Phase II Report

INDUSTRY SECTOR

Program in Energy, Environment, Resources and Sustainability

A Certificate Program jointly offered by

Center for Energy and Environmental Policy

Tata Energy Research Institute

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he Office of International Programs and Special Sessions, University of Delaware

Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Group Statement
Industry Sector

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August 1996

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Sustainable Development in the Industrial Sector

I. Overview

Since independence, India has seen rapid growth in all sectors viz., industries, transportation, agriculture and domestic. Industrial growth for the year 1995-96 is estimated to be 12%. Liberalization and globalization policies pursued by the Government of India since 1991 have stimulated high industrial growth.

Such rapid growth is expected to continue into the 21st century. Fossil fuel consumption will increase, leading to burdens on the environment (including threats to air and water quality). The industrial sector will play a key role in continued growth. It will be a key source of rising energy demand, as well. And, decisions made in the sector concerning the production of goods will determine resultant emissions.

This pattern of development has given rise in India to concerns that the country may be heading toward an era of unsustainability. Borrowing from the widely accepted definition promulgated by the WCED in 1987, sustainable development can be defined as:

1. Meeting the needs of the present, while
2. Empowering future generations to meet their needs for development, and
3. Ensuring that development observes the natural carrying capacities of the environment, and
4. Attempting to eradicate poverty.

Thus, unsustainable development occurs when: a society fails to meet the needs of its members; leaves a legacy of environmental and social problems that future generations in the society must bear; routinely exceeds the natural carrying capacities of local environment through economic and social practices that place growth ahead of social, environmental and economic harmony; and fails to alleviate poverty for some of its communities as the "cost" of progress.

The rapid changes underway in the Indian Industrial Sector can be a source of sustainable or unsustainable development, depending upon the decisions made in this decade and the future. Since the Industrial Sector is a key source of decision-making about technology, and since technologies often have 20-100 years of usefulness, the decisions of this sector can be very important to India's future. In this respect, the Industrial Sector cannot be seen in isolation from the energy or environmental sectors of the society. Rather, industry needs to accept its links with other sectors and to recognize its responsibility for making decisions that lead to optimal energy efficiency and a cleaner environment.

II. The Problem of Unsustainability in the Industrial Sector

1. Liberalization and globalization of Indian economy have led the Industrial Sector to be competitive and to bridge several supply/demand gaps. But, rapid industrial growth has also often led to higher pollution rates that exceed natural carrying capacities.

2. Some of the industrial products viz., CFC, are direct threat to the environment and, thus, need to be phased out.

3. Material wastage and losses in industry remain high. At the same time, the actual cost of disposal is rising sharply as landfills become scarce.

4. In a bid to be competitive, industries are going toward automation, but this leads to increased unemployment. Such unemployment may be offset when new industries, with new employment needs arise. However, often the effects of economic displacement overwhelm local social capacities to respond. As the WCED notes, in such circumstance, adversely affected communities may be forced to accept "dirty" industries to increase employment. And, such communities may be unable to maintain infrastructure systems that protect the local environment, with the result that rising unemployment reinforces economic and social practices that are unsustainable in character.

5. Deforestation, land degradation, resource depletion, and human displacement that result from mining and harvesting natural resources for industrial development also contribute to a condition of unsustainability.

6. Absence of environmental compliance and reporting in the Industrial Sector also encourages unsustainability. There can hardly be any guarantee that sustainability will become an integral part of organizational requirement and principles without regular environmental audits and assessment.

7. A key problem of unsustainabiltiy is rising energy intensity that often accompanies the initial decades of rapid industrial growth.

8. Current industrial standards (e.g., boiler) and codes often discourage the adoption of energy efficienct technologies.

9. National policies related to the Industrial Sector emphasize economic returns, with little direct consideration of social and environmental factors that may lead to unsustainability.

10. Urbanization and industrialization often go hand in hand. But this results a more rapid expansion of production facilities to cope with effects of the rapid growth. This leads to unsustainable urban development.

III. Key Requirements for a Sustainable Industrial Sector in India

1. Industry needs to absorb state-of-art technologies, so as to compete in international markets, requiring revamping/modernization, in meeting international norms of energy consumption and international regulations, by encouraging private/foreign investments.

2. Since prevailing licensing procedures are time consuming resulting into delays for implementation of relevant technology, they should be changed.

3. Industrial Sector needs to reduce its dependence on public utilities which are unreliable, leading to loss of productivity.

4. Tax/incentive systems should encourage the investment in greener utilization of the environment.

5. Industrial Sector should increase its R&D capability to improve industrial productivity while increasing energy efficiency and safeguarding environmental quality.

6. Integrate industrial energy-efficiency planning with national industrial development strategy.

Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Project Title:
Conservation of Natural Gas for Maximization of Fertilizer Production

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August 1996

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Conservation of Natural Gas for Maximisation of Fertiliser Production

I. Overview

Economic liberalisation of the last few years has touched almost every segment of India's economy and the fertiliser sector is no exception. Various sectors of the economy are in a state of flux at present and it will take time to adjust to the changing conditions.Winds of economic change are affecting the rural and agriculture scene in the country. With the onset of reforms in the country's economy, the fertiliser industry is under tremendous strain to compete with global market prices. Phosphatic fertiliser, in particular, is under great pressure due to recent policy reforms made by the Government of India during the last five years. Nitrogenous fertiliser production is also smarting under cutbacks in natural gas supplies and increasing prices of petroleum products.The natural gas cutbacks were due a priority change of the Government that permits more gas flow to the power sector. These developments have seriously affected fertiliser production in the last three years. The restricted supply of natural gas (NG) has resulted in a fall in fertiliser production and the energy consumption per tonne of fertiliser produced has therefore shot up as the energy consumption in various drives does not reduce in proportion to the lower production rate.The abrupt increase in energy consumption per tonne of fertiliser together with a drop in production makes the operation of the fertiliser sector increasingly uneconomical and raises issues of environmental sustainability due to the possible depletion in the nutrient level of soil on account of inadequate availabilty of fertilisers. .

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Based on 1993-94 data, India's annual requirement of nitrogenous fertiliser is 19 million tonnes against a production level of 15.7 million tonnes, thus leaving a wide gap of 3.3 million tonnes . This gap is expected to worsen in the future due to the imposition of cut in natural gas supply from the Gas Authority of India Ltd.

A vibrant agriculture sector is a prerequisite to food security and reasonable nutrient intake levels for India's large population. A healthy agriculture sector is also vital for increasing Indian exports and maintaining reasonable prices of agricultural commodities in the country. The economic viability of the Indian agriculture sector depends, in turn, upon timely inputs including fertiliser available at cost-effective prices. Therefore, fertiliser availability and its cost are important for the robustness of Indian agriculture. Adequate production of fertiliser, to ensure sufficient agriculture production by maintaining proper nutrient ratios in the soil within the country without depending upon imports, represents an important step towards sustainability. Because fertiliser is a strategic input for Indian agriculture, a certain measure of self-sufficiency in its production is necessary. Too much dependence on imports can lead to a serious problem. Apart from the problem of high and fluctuating foreign prices, the required quantity of material may not be available in the international market at any point in time. Even if it is available, India may not have foreign exchange to pay for it. On several occasions in the past, India has been gripped by a serious balance of payments crisis leading to acute shortages of foreign exchange. To meet the existing demand-supply gap of fertiliser, the

augmentation of domestic fertiliser production is needed including the addition of new capacity and retrofitting existing plants. To address the natural gas bottleneck, it is proposed that India adopt mixed fuel firing arrangement of its ammonia plants using naphtha to augment limited NG supplies . This option could help to meet the objectives of environmental and social sustainability while also resulting in economic benefits to the country.

The provision of naphtha as a standby fuel will not only lead to enhanced production but per unit energy consumption shall also come down. This modification can be environmentally friendly and India has adequate reserves of naphtha and sufficient facilities to implement this proposal.

This project will result in following benefits:

a) **Economic benefits-** The implementation of the project will lead to higher fertiliser production and thus dependence on imported fertiliser (which is typically more costly) will be lessened. In addition, reduced per unit energy consumption will also lead to economic benefits.

b) **Environment benefits-** Naphtha, being one of the cleanest fossil fuels, will not pose significant adverse environmental impacts. Thus the objective of higher productivity with reduced energy consumption can be achieved without harming the environment. In addition, if adequate quantities of fertiliser could be made available to the farmers, at cost-effective prices, it will result in proper nutrient levels in the soil due to appropriate use of fertiliser.

c) **Social benefits-** A fall in fertiliser production often leads to shortages in its supply to farmers (or farmers avoid its purchase due to higher cost on account of lesser availability) and therefore crop yield is adversely affected. This ultimately results in losses to small farmers and agriculture at large. Therefore attempts to boost fertiliser production shall bring positive socio-economic benefits to small farmers, who represent the bulk of India's farming population.

II. Project Proposal For Indo Gulf Fertiliser And Chemicals Corporation (IGFCC)

In the past, the fertiliser plants on Hazira-Bijaipur-Jagdishpur (HBJ) pipeline have frequently faced the problem of restricted gas supply from the Gas Authority of India Limited (GAIL) which ultimately resulted in production losses. IGFCC has sustained such losses due to restriction in gas supply in previous years but it was substantial in 1994-95. An analysis of the past data was made to find out the number of days the plant faced shortage / restriction. It was found that nearly 25% to 40% of the days there was shortage of gas supply during one year. Therefore, it is proposed that IGFCC adopt for dual firing system in its production unit.

III. Brief About IGFCC

Indo Gulf Fertilisers & Chemicals owns a gas based fertiliser complex at Jagdishpur, UP. This is one of the most modern gas based plants in the country producing 1,350 tons/day Ammonia and 2200 tons/day of Urea with other offsite facilities. The plant was

commissioned in 1988 and since then has been running at its rated capacity (when fuel is available). The fertiliser plant was originally designed with natural gas as the feedstock for ammonia production and a dual fuel (NG or liquid fuel) firing system for steam & power generation. Therefore, fuel for power and steam generation was changed over from NG to liquid fuel (naphtha for gas turbine and fuel oil for service boiler) after the imposition of a cut in natural gas supply from GAIL in 1993-94. In order to maximise production by way of better on-stream utilisation, IGFCC has already undertaken a revamp project to improve the maintenance & operational reliability of the process plant equipment and systems. As a first step to overcome the limitation of natural gas supply, IGFCC have already implemented a dual fuel firing arrangement for the auxiliary steam super-heater of its ammonia plant in the revamp project. However, the size of the restriction in supply of NG in previous years indicates that the ammonia plant will have to be run at reduced capacity, even if naphtha is used to fire the auxiliary steam super heater burners. Improvement in the supply of NG is not expected in the future at least by 2000 as well as some more plants are also expected to be commissioned in the future and supply per plant may, therefore, shrink even further.

For this reason, it is proposed to make provision for mixed fuel firing in the primary reformer burners of the ammonia plant so that fertiliser production is not lost due to natural gas restrictions in the future.

IV. Brief Process Description Of an Ammonia Plant

The desulphurised natural gas is mixed with steam and passed through a primary reformer for reforming reaction. The gas from the primary reformer leaves with a methane content of 11%. Further reforming takes place in a secondary reformer where process air is also introduced to provide a hydrogen - nitrogen ratio of 3:1 which is suitable for ammonia synthesis.

The mixture of gasses leaving the secondary reformer at 990 °C is passed through the waste heat boiler where high pressure steam is generated. After waste heat recovery , the gas mixture, consisting of hydrogen, nitrogen, carbon-monoxide and carbon-dioxide along with a small percentage of methane and argon is sent to the shift convertor catalysts, to convert carbon monoxide to carbon dioxide. Carbon dioxide gas is removed in the CO2 removal section of the plant by absorption in potassium Carbonate solution.

A pure hydrogen and nitrogen mixture in a ratio of 3:1 after compression , is sent to the ammonia convertor where ammonia is formed. The heat from the reaction is recovered in a waste heat boiler by generating high pressure steam. (See the process flow diagram, Annexure-I for details).

At the rated capacity of the plant, typical natural gas requirement is as below:

Natural gas as feed to primary reformer of ammonia plant	9,000 Mkcal/day
Natural gas as fuel to primary reformer of ammonia plant	3,100 Mkcal/day
Natural gas as fuel to Auxiliary steam super heater of ammonia plant	700 Mkcal/day

Total Gas required	12,800 Mkcal/day

Details about the primary reformer system, its catalyst tubes, details of reformer burners, design operating parameters, fuel specifications & existing naphtha storage and its transfer facilities are described in annexure-II.

V. Preliminary Details Of The Proposed Modification

5.1 Naphtha Storage & Transfer Pumps

From the main naphtha storage tank located in the offsite storage tank, it is proposed that liquid naphtha shall be pumped to the ammonia plant area via transfer pumps. The pump shall be driven by an electric motor and the need for a minimum flow valve returning to the storage tank is foreseen. The pump is to be located in the storage area. Automatic starting of the stand-by pump is foreseen in case the operating pump trips.

5.2 Naphtha Deaeration

From the transfer pump, liquid naphtha shall be fed to the deaerator for oxygen removal in order to avoid potential gum formation in the naphtha evaporators. Inside the ammonia unit, pressure and temperature measurements for naphtha make-up shall be provided.

The proposed modification envisages introduction of liquid naphtha at the top of the deaerator and its stripping with purge gas from the ammonia absorption unit. If purge gas is not available, natural gas from the plant battery limit can be used as the stripping agent. The dearator shall be operated at a pressure of about 6 kg/cm2 which is sufficient to transfer the stripped naphtha to the evaporators without any pumps.

The stripping gas flow shall be controlled by an upstream flow controller working in split range on the purge gas supply line and the natural gas supply line. In case of interruption of purge gas and for start-up, natural gas will automatically be introduced. The pressure shall be controlled by a downstream split range pressure controller passing the gas to the reformer fuel system. In case the fuel line is blocked, the gas will automatically be vented to flare.

The deaeration is expected to take place in two packed beds with a total height of 4 meters packed with 1" pall rings which assures complete deaeration under normal conditions.

The liquid hold-up for the horizontal surge drum shall be placed below the deaerator. The stripping tower shall correspond to half hour operation at full load in order to handle upset conditions in case of transfer pump failure. In case of high level in the horizontal surge drum, the naphtha supply to the deaerator is interrupted and in case of low level, the naphtha supply to the evaporators is interrupted.

5.3 Naphtha Evaporation

The stripped liquid naphtha from the deaerator shall be routed to the naphtha evaporators and completely evaporated and heated to 220^0C using steam (40 Kg/cm2) quenched to 300^0C in order not to exceed the allowable temperture differtial across the tube sheet in the evaporator.

Downstream of the evaporator, a knock-out drum shall be installed in order to catch droplets, if any. The liquid carryover is returned to the evaporator by gravity.

The evaporator pressure shall be controlled by pressure controller operating on the valve on the liquid naphtha upstream of the evaporators adjusting the evaporation rate. The actual capacity shall be set by the naphtha fuel gas flow controller.

If cleaning of one of the evaporators will be required, complete blocking of the evaporator by means of blinds is foreseen while the other evaporator will be in operation. Both evaporators shall be sized for the full naphtha evaporation capacity corresponding to 100% load.

During start-up, it is foreseen to operate the evaporator at reduced load by using the water cooled naphtha condenser returning to the naphtha dearator via the condensate return pump. In this case the load on the evaporators is controlled by a flow controller upstrem of the condenser. In case the pressure builds up in the naphtha condenser because of uncondensable gasses, a small bleed to the flare has been foreseen.

This arrangement will ensure a certain load on the evaporator before evaporated naphtha is introduced to the reformer and facilitates a smooth start-up.

In order to avoid condensation of naphtha after evaporation, the naphtha vapour lines downstream the evaporators shall be jacketed, using medium pressure steam.

5.4 Firing Control Of Primary Reformer

The amount of evaporated fuel naphtha sent to the primary reformer shall be controlled by flow-controller upstream the mixing point with natural gas and purge gas.

The natural gas fuel is controlled by a flow controller which in case of low fuel gas pressure can be overruled by a pressure controller maintaining a minimum acceptable burner pressure.

The control of purge gas fuel and excess synthesis gas fuel shall remain unchanged.

Before mixing natural gas, purge gas & synthesis gas with evaporated naphtha, preheating up to 220^0C shall be required in the fuel gas heater using medium pressure steam quenched to 300^0C.

The evaporated naphtha line shall be steam jacked by medium pressure steam up to the mixing point with preheated purge gas & natural gas. Downstream of the mixing point only steam tracing with medium pressure steam is foreseen and the existing piping can be reused.

The burner tips of the existing John Zink burners will be changed out which will allow for the following combination of fuels.

- Natural gas
- Natural gas & purge gas
- Natural gas & naphtha
- Naphtha & purge gas

In case excess synthesis gas is available, this can be fired in a mixture with the above mentioned combinations.

It is noted that all purge gas, excess synthesis gas & natural gas is preheated in an NG preheater up to 220^0C in order to avoid condensation after naphtha is being added. This configuration shall allow switch over natural gas firing to naphtha firing up to the full load without condensation risk i.e. full flexibility between naphtha and natural gas firing.

For start up of the primary reformer, natural gas is foreseen and when the burner pressure is sufficiently high, substitution with naphtha can start.

The modified flow diagram is enclosed as Annexure - III.

5.5 Flare System

The discharge of pressure safety valves and vents from pipes and eqipment containing naphtha shall be routed via a separate 10-inch flare header to a new knock-out drum located close to the existing flare stack. The new flare header shall allow draining to the knock-out drum as condensation of naphtha when being released to the flare. After the knock-out drum, combination with the existing flare stack can be made.

VI. Cost-Benefit Analysis Of The Proposed Scheme Of Naphtha Firing System in Primary Reformer Of Ammonia Plant

6.1 Cost of modification,(Rs Lakhs) 814.16

6.2 Payback Period:

Period of study		Apr'94 to Jan'95 & Apr'95 to Nov'95
Total operation days	Months	18
Total no. of days NG was restricted apart from unavoidable reasons	Days	136

NG for Ammonia Plant (Feed & Fuel to primary reformer)	MSM^3 / day	1.36
NG Calorific value	KCal/Sm^3	8500
Shortfall in Ammonia production (due to restricted NG supply)	Tonnes/day	72
Total estimated cost of modification	Rupees/lakhs	814.16
Additional cost due to higher fuel cost (per day)	Rupees/day	58241
Additional profit due to additional urea production	Rupees/day	300000
Pay Back Period @ 12% interest on 50% of borrowing for capital cost of the project.	Years	5
B/C ratio		1.11

Environmental benefits

The implementation of this scheme shall not load the environment as compared to the natural gas firing system so far as the pollutants like carbon dioxide and sulphur dioxide are concerned. Replacement of natural gas with naphatha is environmentally friendly and any other feedstock like coal or heavy oils would have caused more damage to the eco-system and the energy consumption per unit of fertiliser production of coal/heavy oil based plants is normally much higher making them costly to operate.

VII. Current Barriers

7.1 Policy issue

To date, there is no clear-cut policy put in place by the Government for the allocation of natural gas to various sectors. This has led to sudden cuts and disruptions in committed supplies to IGFCC, causing loss of productivity. Even, flexibility of alternate (to natural gas) feedstock viz., naphtha could have been built-in, if GAIL had indicated regarding likely shortfall in Natural Gas production.

7.2 Pricing issue

Natural gas, being one of the cleanest fuels has become a very attractive alternative for power generation. Thus, a pollution problem is overcome with the utilisation of natural gas in the power sector. When gas-based fertiliser plants were installed, there was no indication by the Gas authority of India that there would be shortfall in gas supply. Therefore, none of the fertiliser plants on the HBJ pipeline have provided any facility for mixed fuel firing in ammonia plants. Their installation will lead to an increase in the capital cost of the plant and the industry has no reason to incur high capital expenditure without hope of a return on investment.

At present, the prices of raw material and finished product are conrolled by government so as to boost agriculture production. Continuation of this policy on a long term basis is uncertain, leading to dampening of initiatives for capacity expansion.

VIII. RECOMMENDATIONS

- Due to frequent cut in NG supply imposed by GAIL,the operation of the fertiliser plants turns out to be uneconomical at times. Therefore, Gas Authority of India should allocate adequate quantity of gas to fertiliser sector by defining the percentage of cut being imposed on a permanent basis to avoid frequent impositions of cuts which cause thermal and mechanical and mechanical shocks to the plant in addition to its profitability.
- The Government of India should establish clear-cut guidelines regarding fertiliser pricing policy so that private / foreign investments could be attracted. The assumptions for computing the pricing norms are ad-hoc in nature. The pricing of naphtha for fertiliser production is controlled by the Government of India and is supplied at concessional rate to fertiliser industry. In case, this policy is discontinued due to change in Government's view point, it may lead to higher pay-back period for this proposal.

The fertiliser sector, being highly energy intensive needs to ensure

- monitoring of all critical parameters which affect energy consumption, without burdening the environment with respect to polluting constituents.

captive utilities and not depend on state owned utilities.

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ANNEXURE I

DETAILS OF CATALYST TUBE

No. of tubes	288 (2x8x18)
Tube Material	25/35 Cr, Ni, Nb, Ti
Design temperature	912°C
Tube inner diameter	129.0 MM
Tube outer diameter	152.0 MM
Tube heated length	11370 MM
Tube overall length	12090 MM

DETAILS OF BURNERS

Manufacturer	John Zink Company Ltd., Italy
Number of Burner	576
Type	Radiant Wall Forced Draught (HTALP No.13)
Normal heat release for burner	270313 KCal/Hr
Max. heat release per burner	345000 KCal/hr
Min. heat release per burner	65.000 KCal/hr

DESIGN OPERATING PARAMETERS

INLET CONDITIONS

Fluid Temperature	520°C
Manifold pressure	34 kg/cm^{2}g
Design temperature	550°C
Design pressure	38 kg/cm^{2}g
Feed flow – Natural Gas	43814 Nm^3/hr
Feed flow – Recycle gas	2430 Nm^3/hr
Feed flow – Steam	153141 Nm^3/hr

OUTLET CONDITIONS

Fluid temperature	798°C
Manifold pressure	32 kg/cm^{2}g
Design temperature	829°C
Design pressure	38 kg/cm^{2}g
Effluent flow gas	140254 Nm^2/hr
Steam	111251 Nm^3/hr

FUEL SPECIFICATION

NATURAL GAS

Natural gas is used as fuel and the primary reformer is capable of using any of the gas Composition listed below as fuel stock as well as any mixture between them.

Natural Gas Analysis

	A	B	C	D
Composition (Mol%)	Vol %	Vol %	Vol %	Vol %
CH_4	69.24	78.84	83.29	98.39
C_2H_4	13.05	7.23	7.60	1.40
C_3H_8	9.27	4.59	2.10	0.10
C_4	4.01	1.98	–	–
C_5	1.26	0.50	–	–
C_6	–	0.26	–	–
CO_2	1.75	6.49	6.90	–
N_2	1.39	0.01	0.01	0.01
O_2	0.03	0.10	0.10	0.10

H_2S (Normal / Max.)	10/50
Pressure upstream PCV	3.0 kg/cm²g
Temperature	30°C

SECONDARY FUEL

a) Purge Gas

Composition (Mol %)	
H_2	64.89
N_2	21.94
NH_3	0.17
CH_4	9.78
Ar	3.22

Sheet 4

Pressure	3 kg/cm²g
Temperature	40°C
Available amount – Normal	4200 Nm³/hr
Available amount – Maximum	18200 Nm³/hr

) Surplus Synthesis Gas

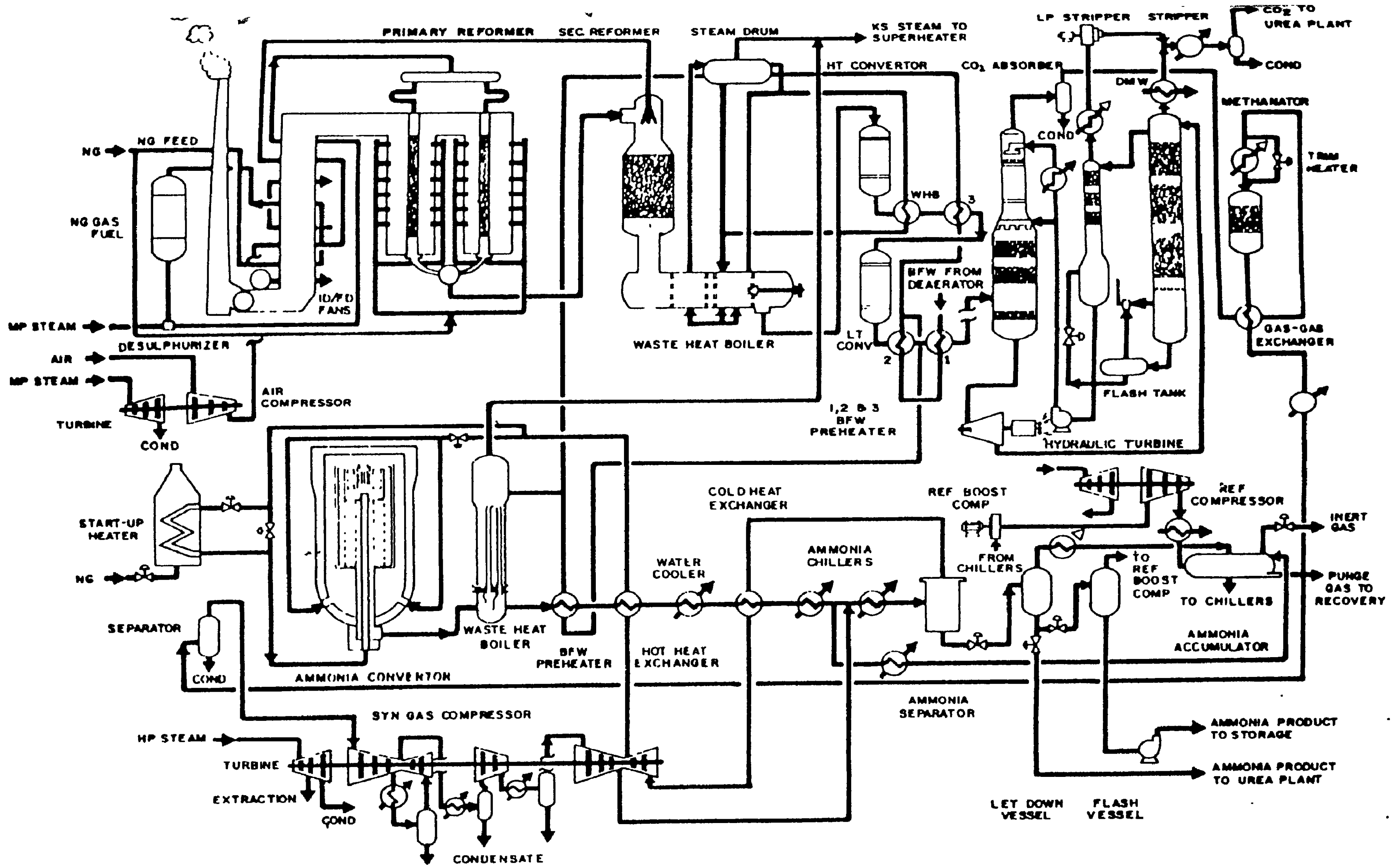
Composition (Mol %)	
H_2	74.09
N_2	24.72
CH_4	0.89
Ar	0.30
Pressure	3 kg/cm²g
Temperature	38°C
Available amount – Normal	0 Nm³/hr
Available amount – Maximum	10000 Nm³/hr

NAPHTHA (PROPOSED FUEL)

The proposed naphtha fuel to be used in primary reformer furnace shall have the following specification (typical) :

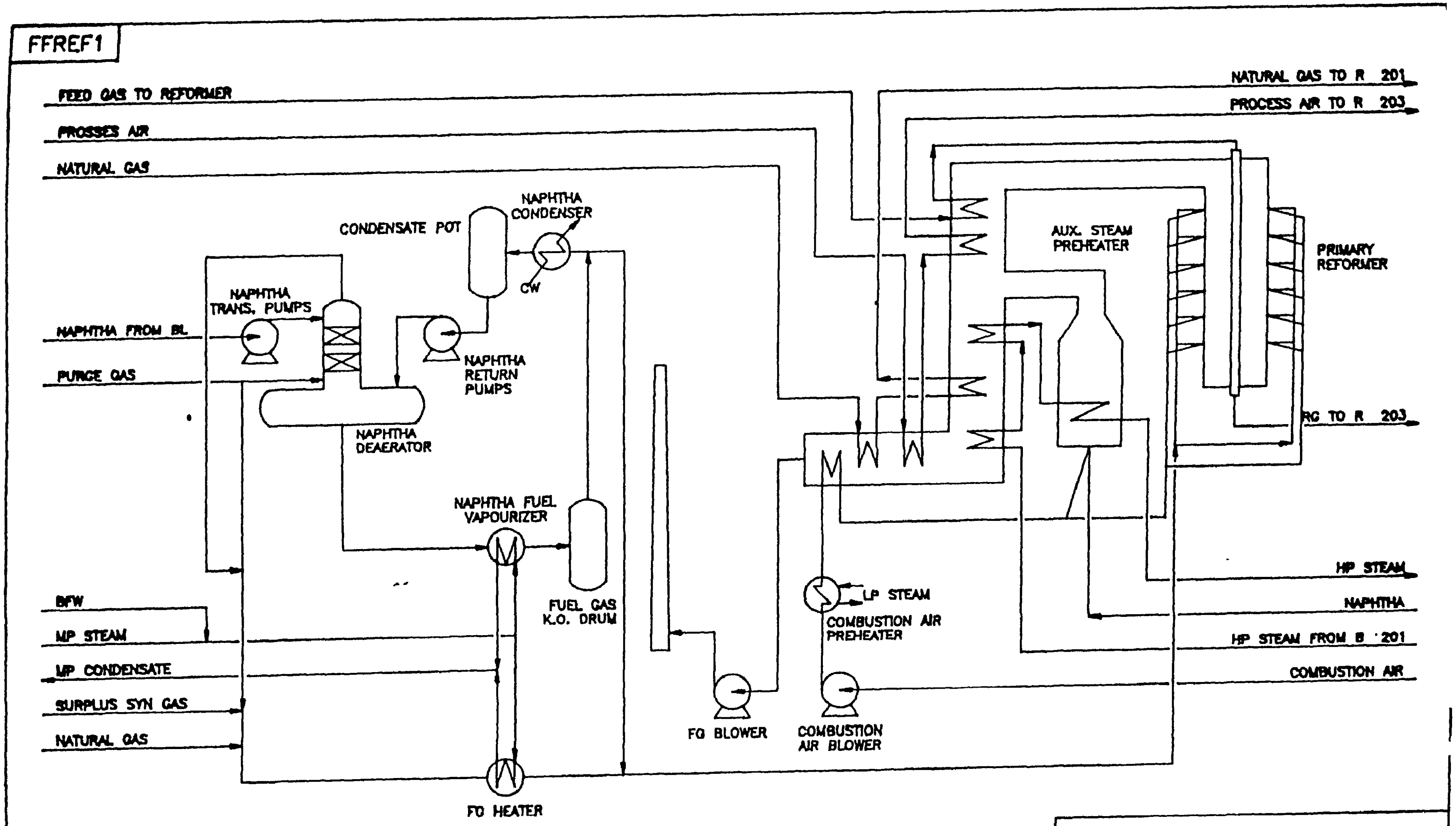
1)	SP, GR @ 150	0.7 to 0.73
2)	Aromatics + Olifins	20% (Max.) by VOL
3)	Paraffins + Naphthene	79.80% to 90.80% by VOL
4)	Olifins	0.08–0.15 VOL
5)	Bromine No.	0.15–0.35
6)	C/H ratio	5.5–5.8
7)	Sulphur	100 PPM (Max)
8)	Lead Content	1 PPB by Wt. (Max.)

ANNEXURE II



IGFCC	TITLE- AMM. PROCESS FLOW DIAGRAM	REV NO.				PREP BY PK SRIVASTAVA	UNIT	PROJECT- IGFCC
		DATE				CHD.		SHEET 1 OF 1
	DRG. NO.	REV. BY						

ANNEXURE III



INDO GULF FERTILISERS AND CHEMICALS CORPORATION LTD.
JAGDISHPUR

TITLE - MIXED FUEL FIRING IN PRIMARY REFORMER OF AMMONIA PLANT AT IGFCC

PROJECT	SCALE	DRAWING NO.	REV

JOB NO.

REF. DRAWING NO.

NO	DATE	REVISION	DRN.	CHD.	APP.

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Group Statement
Energy Sector

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Energy Sector in India and Sri Lanka: Present Scenario and Sustainability Issues

The Problem of Unsustainability

As with many developing economies, the demand-supply gap in the energy sector and more specifically in the power sector in India and Sri Lanka is increasing at an alarming rate. At the same time, rising pollution from this sector is the largest contributor of air-borne contaminants, especially in India. This implies that any effort to solve the demand-supply gap must address not only economic but also social (especially health related) and environmental costs. Each country has a range of problems which must be addressed. These problems are briefly reviewed below.

- ***Large unsatisfied demand*** : There is a peak demand shortage of 19% and an energy deficit of 9.2% at present. Peak demand and the energy requirements are expected to grow in the future due to *rapid industrialization and structural changes* in development. The present economic growth rate is about 5% and is projected to increase to 8% in the coming years. Changes in consumption patterns have also resulted in increased peak demand. In addition to this there is a large unsatisfied demand in the unelectrified Indian villages, which constitute about 60 % of the total villages. This places a serious limitation on the material conditions of people living in much of India's countryside.

  Poor hydro-thermal mix: India has ample hydro potential but has failed to make optimal use of this clean energy source which is often proximate to rural areas. While the country has a hydro-thermal (mainly coal based) mix of 25:75, analyses of Indian needs suggest

the ideal mix is 40:60. The current mix seriously impairs the peaking capacity of the system on one hand and results in inefficient operation of thermal power stations during off-peak periods.

Low plant load factor (typically 60-65%) and ***high T&D losses*** (20-23%) result in reduced net availability and high costs. For comparison, average load factor in China is 70-75% and T & D losses are less than 7.5%.

Poor generation and end-use efficiencies. Lack of incentives/penalties related to performance efficiencies in the power sector and lack of awareness of the full range of opportunities to decrease energy intensity of output has resulted in poor operating efficiencies throughout the country's power sector.

Poor quality of coal and limited geographic availability: Much of India's coal has a very high ash content (typically 40-45%), which leads to significant air pollution from its use. As well, the country's coal reserves are concentrated in a few areas, resulting in the hauling of coal over long distances to generating centers. Inadequate railway service compounds the problem. The transport of electricity from mine mouth power plants to load centers is not a solution because the country's inefficient transmission systems leads to huge losses.

Environmental degradation : Problems of waste (ash) disposal and air pollution associated with thermal power plants has led to serious health-threatening problems in India's cities. (Measurements of SO_2 and SPM pollution in Delhi, Bombay and Calcutta by World Health Organization indicate that air quality is below that required for healthy respiratory functioning).

- ***Reliance on diesel generator sets*** by domestic, commercial and industrial consumers due to inadequate / unreliable power supplies results in inefficient use of scarce resources and significant pollution.
- ***Subsidized tariff*** for certain sectors (including agriculture and cottage industries) result in huge unrecovered costs and inefficient utilization of power in those sectors.
- ***Shortcomings in policies:*** Inadequate emphasis on the development of T&D infrastructure, renewable energy sources and demand side management can all be traced to general policy failure that is evident in the financial difficulties of the state electricity boards.

Efforts solution to some of the problems mentioned above have been typically reactive, i.e., to increase installed capacity (mainly thermal) to meet increased demands. this not only reduces the system's capacity to respond cost-effectively to peak demand but also results in additional pollution damaging to the environment Also to meet increased demands, propelled by economic liberalization, the power sector has been opened to the private sector. Government's efforts to attract private investments in the power sector has resulted in project proposals for a total capacity of about 90,000 MW. Almost all of these are in thermal power plants, more suitable for base load operation. These proposed plants when commissioned could further adversely affect the generation mix and result in increased pollution, ecodegradation, reduced fuel security and depleted resources. The huge financial requirement for setting up the proposed capacities is also likely to strain the economy already facing a significant capital crunch.

Problems specific to Sri Lanka include high population density, greater dependency on hydropower, non-availability of domestic fossil fuels and an increasing gap between demand and supply for electricity with present demand outstripping supply by 30%. The major consumer of electric power is a rural population, which constitutes about 78% of the total population Nonetheless, over 46% of the population in the rural areas is without electricity and resorts to using major forest products. This poses a great threat to already deteriorating forest cover.

It is clear that the Indian and Sri Lankan energy systems are not be able to meet the four major requirements of sustainable development, namely -

- To meet the needs of the present generation
- To empower the future generations to meet their own needs
- To live within nature's the carrying capacities
- To eradicate poverty .

Building A Sustainable Energy Future

Abundant and cheap supplies of energy have been a locomotive for economic development, especially for growing economies like India and Sri Lanka. The use of cheap energy sources - especially fossil fuels have also posed well-known environmental problems. This highlights the close linkages among Energy, Environment and Economy and, as a result, the need for an **integrated planning and management strategy to realize a sustainable energy system**. It is imperative (1) to look for energy sources which are plentiful and are not damaging to the environment; (2) to develop technologies (generation, T & D , end-use and renewable energy)

that make best use of energy sources without adverse environmental effects; (3) to efficiently utilize sustainable resources and to establish financial and regulatory systems to fund and promote the development of sustainable energy systems.

Some of the elements of a sustainable energy model for India and Sri Lanka are as follows:

- **Renewable energy sources**: Renewable sources like wind, solar, biomass, micro/mini and pumped hydro plants can play a significant role in meeting the energy demands of the two countries. In spite of an identified huge potential for these resources in India and Sri Lanka not much progress has been made in tapping these resources due to limitations in existing technologies and policies. Grid penetration of renewables is also very poor owing to the rudimentary renewable energy technologies used and weakness in each country's grid system.
- **Demand-side management**: DSM could play a major role in optimizing the utilization of existing infrastructure without the necessity to add new and expensive capacities. This could be achieved by improving end-use efficiencies, designing tariff structures to promote efficiencies, shaving the peaks and filling the valleys, etc. To capture DSM's potential, structure of financial incentives is needed to encourage user to undertake efficiency improvement plans. This would not only result in efficient utilization of natural resources with associated environmental benefits, but also release scarce financial resources for other developmental projects.
- **Distributed utility approach:** The concept of augmenting central generating stations with decentralized or distributed generation and DSM would go a long way toward reducing T&D losses, reducing capital required for building up T&D infrastructure and improving

reliability of power generation. Distributed utility planning can also make optimal use of renewable energy sources and hybrid systems that rely on locally available resources.

Clean coal technologies: Coal, being the only fossil fuel resource available in abundant quantities will continue to play a significant role in the power sector. Clean coal technologies like Integrated Gassification Combined Cycle (IGCC) technology, coal beneficiation, fulidized bed combustion technology and utilization of fly ash in road and building materials can make use of coal a less harmful bridge to a sustainable energy future.

Biomass: Biomass is one of the most abundantly available resources in Sri Lankan and, only to a slightly lesser extent in India. Given the right policy initiatives and technologies, biomass could be utilized to meet considerable amount of energy demands, especially in the rural domestic sector, thereby reducing the pressure on other forms of commercial energy.

Attempts to take a sustainable path by encouraging power generation from renewables, the adoption of demand side management techniques. the use of energy efficient technologies and local energy sources such as biomass have not worked well to date. This is due to certain factors including the lack of financial incentives and inefficient utilization of available financial resources, lack of appropriate technologies and shortcomings in policies. As a result investments in sustainable energy options has not been up to the mark and is far below what it should be for rapidly growing India and Sri Lanka.

Projects can be identified to develop a sustainable energy model for India and Sri Lanka. The projects proposed here are in the areas of:

- Renewable Energy Sources
- Demand-side Management
- Financing Tools for Energy Conservation Projects
- Development of Policies for Popularization of Agro Based Biomass Technologies.

Together they incorporate the key elements of sustainability that will need to be the foundation for a new energy direction for India and Sri Lanka.

Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Project Title:
Sustainable Path for Energy Sector in Sri Lanka: A Case of Bio-Gas System

Investigator:

L. U. Liyanage

August 1996

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USA

Sustainable Path for Energy Sector in Sri Lanka:
A Case of Bio-Gas System

Introduction

The efficient use of abundant resources is necessary to accomplish the objectives of sustainable development strategy. The four principal objectives of sustainable development are:

to meet the needs of the present generation,

to empower the future generations to meet their own needs,

to live within the carrying capacity of the earth, and

to eradicate poverty.

To achieve these objectives energy sector development in Sri Lanka should be based on energy efficiency improvements , demand side management especially during peak hours, and capacity additions by renewable resources. It has been found that the efficiency improvements ranging from 5 - 15 % alone could reduce the expected peak energy demand in the country by 15 - 23 %. The renewable energy options that are available for capacity additions could be identified as mini - hydro power, wind power, solar energy, and biomass fuel. Although the biomass at present is not widely used for electricity generation it still provides almost 70% of the country's primary energy consumption as it is the most readily available resource. The use of biomass at present is not efficient. The biogas technology is one of the options available for efficient use of biomass.

Objectives of The Study

This study will focus on biogas development in Sri Lanka. The principal objective of the study is to understand the technological, institutional. and political barriers that hinder the

promotion of a sustainable renewable energy technology and to study the possible measures that could be taken to overcome these barriers. In the light of the above objective, the study will attempt to:

- find-out actual energy and fertilizer potential through biogas,
- identify any problems or difficulties that farmers face while commissioning, operation and maintenance stages of the system,
- understand the steps that are necessary for future developments.

Energy Efficiency - The cheapest energy resource

Energy efficiency may be one of Sri Lanka's promising sources of energy. Energy planners often ignore the fact that the society values energy not for its own sake but for the services that energy provides. Kilowatt-hours of electricity, barrels of oil, and bundles of fuel-wood are important only for the light, heat, and motive power they generate. By improving the energy use efficiency, we gain an eminently feasible compliment to other new sources of energy. Many countries have found that tapping energy efficiency resources is typically less expensive than importing oil and building new power plants, and environmentally preferable as well.

Studies suggest that Sri Lanka's energy efficiency resources are at this point plentiful and potentially cheaper than other energy supplies. Modest energy savings ranging from 5-15% among industries, buildings, hotels, residences and street lighting would reduce expected peak energy demand by 15-23% (Munasinghe, 1988). Actual savings may be even higher by applying currently available state-of-the-art technologies.

Demand Side Management (DSM)

Demand side management (DSM) techniques could also be considered as a viable solution in reducing the peak demand for electricity. The principal objectives of the DSM is:

- to modify the level and timing of system peak demand and reduce electricity requirements through improved end-use efficiencies.
- to develop sustainable DSM programs to compliment capacity additions.

The distinction between increasing end use energy efficiencies and DSM is that the scope of DSM techniques is to increase energy efficiency at peak demand through both policy initiatives as well as innovative application of the state-of-the-art technologies currently available. Adjustments in the tariff structure itself can accomplish some of these targets. For example having a higher tariff for the electricity consumed during peak hours and a lower tariff for the off-peak consumption would eliminate some of the customers peak loads.

Selection of Cleaner Energy Sources For Capacity Additions

Capacity additions to the available facilities may be necessary to meet the demand for electricity. The demand for electricity at present stands around 2000 MW where as the total installed capacity is only 1365 MW (Source : 1). Nearly 60% of the villages are yet to be electrified. With the prospects of rapid industrialization and improvements of standard of living the demand for electricity is expected to grow at an average rate of 8% in the years to come. This requires the present installed capacity to be doubled by the turn of the century and therefore capacity additions may be necessary as the above stated techniques alone may not suffice.

These additions may be in the form of extensions or improvements to the existing facilities or the construction of new power plants. However the selection of the sources for the development should be only after a careful and thorough investigations as most of the developments in the past has shown many environmental implications. Basically renewable energy options provide cleaner sources of energy.

Renewable Energy Options

(1) Hydro Power : Hydro power by its own is a renewable energy source. However it has many environmental considerations depending on the capacity of the facility. Sri Lanka has already harnessed almost its major hydro power potential and in fact the country is greatly dependent on hydro power. Out of the total installed capacity of 1365 MW, 1017 MW being hydro power. (Source : 1). The diesel thermal power plants play almost a stand-by or back-up role. This has shown some times the electricity supply unreliable with prolonged droughts, for example this year with less intense and delayed south-west monsoon caused all hydro-reservoirs to drop drastically and power generation capacity to almost 13% of the total hydro power generation capacity. This resulted in power curtailments extending up to 10 hours a day causing detrimental effects to the economy. Therefore maintenance of proper mix of power generation using different types of sources is necessary.

Construction of two medium scale hydro-power projects have been dragging down for many years for their environmental considerations. However there is an enormous potential of hydro-power still exists in the form of mini-hydro scattered around tea and rubber plantations in the mountainous areas. Total potential of the untapped mini-hydro

sources has been estimated at around 100 MW, with a generation capacity of 400 Gwh per annum. (Source : 1)

(2) Wind Power : Being an island the wind power potential along the coastline of Sri Lanka is very high. Some of the localized potential wind power sites have also been identified inside the country specially in the central hill country. However the attempts to tap this renewable and clean energy source is very few.

Cost effective technology is also available within the country and therefore it provides a promising alternative.

(3) Solar Power : Sri Lanka is a tropical country. Therefore we have got a plenty of solar power potential. However like in the case of wind power, tapping solar energy has not been much attempted. Although the presently available PV technologies are considerably expensive, technological improvements taking place in this field indicates considerable reductions of the cost in the near future. However other forms of cost effective technologies already exists within the country, for example , solar water heaters or cookers, which could be used to reduce the pressure on other forms of commercial energy, electricity and oil. Solar water heaters can easily be introduced to hotels by which heating water upto 60 0 c is possible and thereby the use of electricity for heating water could be reduced.

(4) Bio-Mass Fuel : Bio-mass provides almost 70% of the total primary energy consumption in Sri Lanka. It provides cooking fuel for almost 94% of the households. However it accounts only 40% of the useful energy consumption (Source : 1). Many uses

of bio-mass are not efficient and the general availability has caused less conservation attempts.

Introduction of energy efficient cook stoves by several governmental and non-governmental organizations up to a certain extent has been successful. Other technologies adopted for use in Sri Lanka by the NERD Center, are bio-mass gassifires for tea leaf drying and smelting brass, bread baking ovens which save biomass fuel, biogas generation through agriculture waste, particularly paddy straws, and biogas generation through municipal garbage. Lack of appreciation by policy makers, lack of awareness by the public in general, insufficient fund allocations for development and promotion, and inadequate attempts for monitoring the processes has caused many of these technologies being not widely used.

Biogas generation from paddy straw by itself is a sustainable system which fits exactly with the paddy cultivation system of the country. An average farmer having 1 acre of paddy land can provide enough straw to feed a 1 ton capacity generator, which then produce sufficient biogas approximately 1 m3 at a pressure slightly over 1atm for a period of six months. The organic manure left behind in the digester is an excellent bio-fertilizer. Studies have proved that 80% of the straw from a paddy field when digested by the process is all that is required to fertilize the paddy field for the next cultivation. The soil gets naturally conditioned and is restored to its pristine state.

However with all these promising conditions the system is still not widely used by the farmers. Therefore study has been necessitated to understand the underlying barriers and address them properly in order to promote the technology. In this study an attempt is

made to understand the institutional, technological, and policy barriers which hinder the progress. It also attempts to suggest policy initiatives and technological improvements that are necessary to overcome the shortcomings.

Participation of the farmers in the process is necessary to understand the problems that they face and to collect their valuable suggestions based on own experiences which is expected to accomplish through surveys. Ultimately a sustainable strategy for meeting the energy demands of the rural sector can be established. This will reduce to a certain extent the burden on the supply of electricity to villages. Need for conservation and efficient usage of resources and the reduction of land degradation will also be accomplished.

Case Study :Popularization Aspects of the DryBatch Type Straw Fed Biogas System

Background :

Selection of the Project : As discussed in the previous section most of the energy efficient bio mass technologies has not gained enough momentum among the potential users. Therefore looking into the popularization aspects has become necessary as it would help reveal underlying barriers for future developments. Selection of this study was based on the following reasons.

(1) High potential for popularization due to:

(i) bulk availability of raw materials

(ii) the fact that it leads self sustained paddy farming

(iii) its ability to meet energy needs of the rural household

(2) It has a total potential of providing equivalent energy over 50 MW of electricity

(3) It is a zero waste technology

Biogas as an Alternative Fuel : Biogas is a high value fuel-gas comprising 60% to 70% methane and 40% to 30% carbon dioxide. It is a good source of heat energy for domestic use with an average content of about 12 MJ/m3. It also forms a combustible mixture with air which could fuel an internal combustion engines.(Source : 2)

Domestic Uses : Fuel- wood is the principal energy for 70% of our population. Already, some districts have to import this fast dwindling resource from other areas in the country. In the urban settings the situation is acute. Thus biogas is an attractive alternative energy source to be popularized.

Biogas is an obvious alternative to LP gas. Some 2100 tons of it is imported into the country annually at a cost of Rs. 170 million. The organic residue left behind in the digester is an excellent compost which will improve yields of crops several-folds. (Source : 2)

History of Biogas Generation in Sri Lanka : With the hike in oil prices in early 70's, attention of many developing countries were focused in search for alternative sources of fuel. Biogas technology was one such advancing technology by the time. Since Sri Lanka is a country with a farming tradition, one would have expected biogas to be given serious considerations. The early attempts were on Chinese and Indian models of biogas generation, both depend on animal waste. The Agriculture Department was mainly involved in these early attempts. However as late as 1979, six years after the first oil crisis, it has been reported that only two successful biogas units were in operation (Gosling, 1979).

The heavy subsidy on kerosene oil introduced by the government following oil crisis acted as a disincentive in the development of alternative energy sources. From 1979 onwards the subsidy on kerosene was reduced in stages. Several government institutions and non-governmental organizations began to promote biogas as a fuel and have set up extensive programs for biogas technology. Casual estimates made by those involved in biogas promotion works lead one to believe that by early 1984 several hundred units have been set up throughout the country. (Source : 4)

Emergence of Straw Fed Biogas Digester (DryBatch) : Traditional biogas plants based on Chinese or Indian models requires continuous daily feeding of animal waste. To operate a family type unit one needs at least 3 cattle heads. In Sri Lanka the farmers having 3 or more cattle heads is very limited. Therefore the benefits derived through biogas were limited. Social resistance that normally exist in urban areas against handling animal waste has prevented the use of biogas in areas where it is mostly wanted.

After realizing these facts NERD Center of Sri Lanka started research on the possibility of producing biogas from vegetable materials. Many materials were tried including widely available paddy straw, coir dust, saw dust, water hyacinth, salvinia etc. It was revealed, through this research, that straw, the material abundantly available in almost all parts of the island, was the best for biogas production. On average the gas production was about 1 lit/kg/day. (Source : 3)

Salient Features of the DryBatch Type Biogas Unit

The System : The system consists of two parts,

Digester	-for biological processes
Gas Holder	-for on line storage of gas during slack periods of usage and pressure regulation

The digester is made in-situ in brick and mortar. It is a closed vessel in which the internal gas pressure builds up to a level slightly above atmospheric pressure. A simple water seal at the opening ensures anaerobic conditions inside the vessel. The latter is usually constructed below ground level with only the vessel entrance protruding above ground. The gas holder is economically made with used 200 liter oil drums which are connected together. The holder is floated in a shallow pond and its point of equilibrium will vary according to the amount of gas being stored. The level of technology required for the construction is quite low and could easily be executed with facilities available in rural areas.

Operation and Maintenance : The bio mass charge is moistened before sealing the digester on a batch basis. Only maintenance required is to ensure that the clay seal incorporated in the vessel lid is always kept wet. Due to the minimum water content , resulting biological fertilizer at the end of the batch period has an optimum moisture content for easy handling.

Raw Materials : The requirements of a household could be met with a standard 5m3 capacity digester. This will take charge of about 1 ton of vegetable matter. For initial adjustments of C:N ratio require about 100kg of fresh cow dung and 2kg of urea. Once

the vessel is sealed generation of combustible gas will commence in about 2 weeks time and will continue at full capacity for over six months.

Products and By-Products : The standard 5m3 digester charged with straw will yield 1m3 of biogas per day continuously for over six months.

The digested material is found to be an excellent organic fertilizer with a reasonable NPK balance and complete with micro nutrients. A perfect balance could be achieved with minor additives depending on the soil chemistry of the land.

Potential For Energy And Fertilizer Through Biogas :

(Based on DryBatch Type Unit)

In Sri Lanka paddy cultivation is the dominant crop both in terms of land use and dietary importance. Efforts to achieve national self sufficiency in rice have received high priority during the decades following independence in 1948. Therefore by 1988, paddy output has grown remarkably in area and yield. Annual paddy cultivation area has grown from 514000 ha in 1956 to 760000 in 1988 and the yield has grown from 1.5 tons / ha to 4 -7 tons / ha. Growth pattern shows almost a leveling - off thereafter. (Source : 1)

Since the country receives rain from two monsoon periods the paddy cultivation pattern has also been adjusted accordingly and the two seasons of cultivation are "Maha" and "Yala" , with Maha season having the higher contribution both in terms cultivable area and the yield per ha. Total production of paddy in the country is in the range of 2.5 million MT (Source : 5). Paddy left behind once harvested a similar quantity of straw , use of the latter is limited to cattle feed or thatching. Therefore a large quantity of straw goes waste without use and is usually burnt over the field or allowed to decay. Following

table shows the districtwise distribution of available straw with biogas potential.

Paddy : Straw Ratio = 1:1

Assume 80% straw can be used for biogas production.

TABLE : 1 Production of Straw in Districtwise

District	Maha Season (MT)	Yala Season (MT)	Total / Year (MT)
Colombo	16000	14000	30000
Gampaha	38000	36000	74000
Kalutara	44000	43000	87000
Kandy	58000	34000	92000
Matale	58000	14000	72000
N'Eliya	14000	6000	20000
Galle	37000	32000	69000
Matara	36000	37000	73000
Hambantota	120000	84000	204000
Jaffna	12000	-	12000
Mannar	54000	1000	55000
Vauniya	19000	4000	23000
Mullative	18000	7000	25000
Ampara	136000	170000	306000
Trincomalee	59000	16000	75000
Batticaloa	60000	44000	104000
Kurunegala	265000	60000	325000
Puttlum	39000	8000	47000
A'pura	254000	52000	306000
P'noruwa	142000	100000	242000
Badulla	66000	35000	101000
Monaragala	42000	14000	56000
Ratnapura	38000	35000	73000
Kegalle	36000	26000	62000
Sri Lanka	1661000	872000	2533000

TABLE 2 : Potential Biogas from Straw

(Biogas potential from paddy = 1 m3/MT/day)

District	Potential B.Gas Production (MT)
Colombo	24000
Gampaha	59200
Kalutara	69600
Kandy	73600
Matale	57600
Nuwara Eliya	16000
Galle	55200
Matara	58400
Hambantota	163200
Jaffna	9600
Mannar	44000
Vauniya	18400
Mullativu	20000
Ampara	244800
Trincomalee	60000
Baticaloa	83200
Kurunegala	260000
Puttlum	37600
Anuradhapura	244800
Polonnaruwa	193600
Badulla	80800
Monaragala	44800
Ratnapura	58400
Kegalle	49600
SriLanka (Total)	2026400

Electricity Generation Potential From Straw :

Paddy Production in Yala Season (MT) - 872000
Paddy Production Maha Season (MT) - 1661000
Total Production / Year (MT) - 2533000

Assumptions
(1) Proportion of Paddy to Straw - 1 : 1
(2) 80 % Straw can be utilized for Biogas production

Total Straw / Year (MT) - 2533000
Potential Straw for Biogas - 2026400
Av. Biogas production (1 m3 / MT / day over 6 months)
Total Biogas Production (2026400 / 2) - 1013200
Calorific Value of Biogas - 12(MJ/m3)
Total Energy Potential (MJ) - 1013200*12 - 12158400

Consider that the efficiency of petrol engine is 50% and efficiency of induction generator is 80%.
Therefore, Overall efficiency in power generation (0.5*0.8) = 0.40

Total Power Output - 12158400* .40/(24*3600) - 56 MW

Fertilizer Potential:

Studies have shown that the use of bio-fertilizer completely eliminates the requirement of chemical fertilizer to the paddy field. Since annual use of chemical fertilizer for paddy cultivation has been increased to 120 kg/ha NPK nutrients by year 1988.
Therefore total annual consumption of chemical fertilizer - (760000*120/1000) - 91200 MT
Fertilizer potential through biogas is equivalent to 91200 MT of chemical fertilizer.

Existing Barriers For Promotion of Renewable Energy Sources :

(The Biogas Technology in Particular)

The potential for renewable energy will not be realized unless the regulations and incentives in existing energy market are changed. The comparative low level of investment in renewable technology, the inertia of existing energy system, and difficulty of maintaining interest in investment during periods when markets are small and uncertain, all act to slow the rate at which renewable energy technologies will move into the market. The merits of renewable energy technologies are often masked by national policies that subsidize fossil or nuclear energy.

The several obstacles that could be identified in achieving the promotional goals of the biogas technology, some of which may be in common with other renewable energy technologies. These obstacles may be attitudinal, social and cultural, institutional, technological, political or financial.

Social and Cultural Barriers :

Bias towards convenient energy : People usually tend to vote in favor of convenient forms of energy like grid supplied electricity or fossil fuel and the energy derived through the sources like biogas tends to consider as of low quality energy.

Risk Factor : Perception that the investment on new technologies as risky makes the people kept apart from adopting the technology.

Low income : Most of the potential farmers have insufficient income for their own investments. No national or international banks or any other financial institutes that provides monitory assistance.

Inadequate education : Many farmers are not aware of the technology and some others are not aware of how to approach the technology. The education level of the people does not allow them to understand the consequences of inefficient use of resources as the education programs are not adequately effective.

Non participation by the social organizations : Sri Lanka has got a plenty of NGO's and social organizations. Every village has got at least one social organization and therefore there exists a very high potential for promotion through social organizations. Community programs in the past were not satisfactory as the responsibility does not lie with anybody; everybody's work is nobody's work; the importance of social organizations is therefore obvious.

Institutional Barriers :

Institutional Capacity : Technology is left in the hands of few individuals or institutions. They do not possess adequate manpower or resources to carry the technology forward. Very few people have been trained for the special skills necessary in the process.

Inadequate co-operation among institutions : There insufficient co-operation between the organizations that are involved. NERD Center, the inventor of the technology, is an R & D organization which does not have adequate resources for market based promotional activities. On the other hand Industrial Development Board is the government agency for such activities. The monopoly in energy sector lies with Ceylon Electricity Board. These organizations are coming under different ministries and therefore the mutual co-operation is inadequate.

Use of public media : Inadequate use of public media to educate the people could be observed.

Political Barriers :

Policy makers are biased towards conventional energy resources. It is very hard to convince the advantages of renewable energy resources and their potentials.

Energy Pricing : Non existence of rational taxes, subsidies, and other financial incentives in favor of conventional energy sources considerably distorts the energy pricing. Externalities are not taken into account at all. Therefore existing prices does not indicate the real cost. These factors act as disincentives for promotion of renewable energy potions.

Insufficient Funds : The insufficient fund allocations for R & D and promotional activities in renewable energy area are very common both national and institutional levels. There are no incentives for research development and promotion of the technology. There is little involvement of financial institutions or banks in the process.

Absence of Follow-up Programs : There is no established procedure for the follow-up the performance of biogas plants set up throughout the country. Therefore feed back on the problems in the operation and maintenance is limited discouraging the popularization prospects.

Technological Barriers :

Following could be observed as the technological barriers that are not in favor of the promotion.

Limited Capacity: Requirement of certain special skills in which the trained people are limited.

Scarcity of appliances and there spare parts

Lack of knowledge on maintenance

Convenience Factor : The harness of energy in the form of biogas is not convenient as getting a connection to the electricity grid if the latter is available. It requires some involvement of the customer in the process.

Discussions and Recommendations :

Six steps suggested by Brown 1981; Brown and Shaw 1982; of Worldwatch Institute, to promote policies towards a conservation strategy. The biogas technology that put forward meets the conservation needs as suggested. It recycles more resources, encourage energy

conservation and it is a renewable energy technology. It also in favor of the reforestation of the earth. In addition to conservation it meets the needs of the sustainable development. It increases the productivity. Tries to address equitability in terms of income distribution. However the technology has many obstacles in its path to achieving promotional goals.

Addressing Social and Cultural Barriers: Education of the people is a necessary step to overcome many obstacles. Education should not be limited to the emphasis on the salient features of the technology itself, but it should be in the context of economic and environmental background. Diversion of enough funds and the participation of social organizations and incorporation of the program into national level planning are all effective steps to overcome the obstacles. The effective involvement of public media would also be helpful in the process.

Addressing Institutional Barriers: Restructuring the institutions, effective communication, co-operation among the respective institutions and incorporate planning could be the effective steps in the context of institutional framework. The Industrial Development Board can act as the promoter with the private sector participation to run the program in the competitive market environment. The social organizations could be helpful in the process as monitoring agencies.

Addressing Technological Barriers: Training of many individuals and the representatives of social organizations in special skills and appointing them as the mediators who could be found available in almost every village or their immediate vicinity would eliminate the lack of trained personnel. Setting up village based industries which make appliances and attend to the maintenance of the appliances is another necessity.

Addressing Political Barriers: Allocation of enough funds for R & D and promotional activities and promotional incentives in the form of tax concessions for renewable energy and application of rational energy pricing in the case of conventional energy are some of the steps that could be identified to be taken in the right direction towards sustainable development.

Epilogue : Common Challenges :

In the choice of resources to be utilized we should not stare at renewable resources of energy blindly, we should not blow it out of proportion, we should not promote it for the sake of environment per se. Instead we should develop and utilize all resources available, renewable sources of energy included, as a long term endeavor requiring a continuous and sustained effort that will not be subjected to short-term economic fluctuations, in order that we will achieve a successful and orderly transition to a more diversified and balanced structure of energy supply and environmentally sound energy supply system.

(Quoted from : Speaker from the floor, WCED Public Hearing, Jakarta, 26 March 1985)
(Source: 9)

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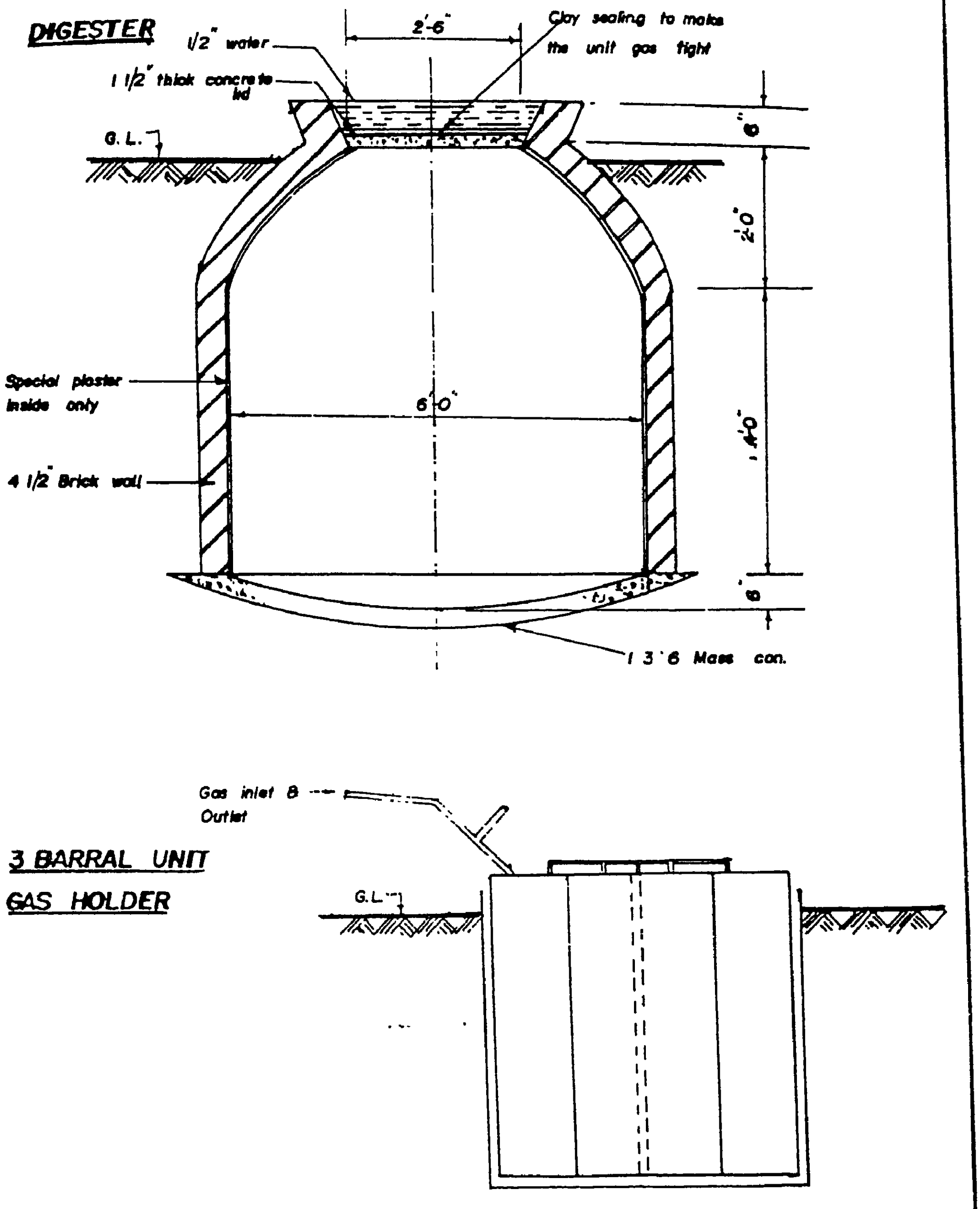

Figure: 4.16

BATCH TYPE

STRAW BIO GAS GENERATOR

NERD CENTRE

CE/89/34-01

Phase II Report

RURAL SECTOR

Program in Energy, Environment, Resources and Sustainability

A Certificate Program jointly offered by

Center for Energy and Environmental Policy

Tata Energy Research Institute

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with the assistance of the Graduate College of Urban Affairs and Public Policy and the Office of International Programs and Special Sessions, University of Delaware

Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Group Statement
Rural Sector

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August 1996

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Problem Statement:
Rural Development Group

The 1991 Census of India shows that 75% of Indian people live in the rural sector, i.e. an enumerated 633 million people are based in rural areas primarily dependent on an agrarian economy for their survival. Similarly, 17 million out of 19.6 million people in Nepal live in a rural/agrarian economy. This dependency on agriculture of various forms and agriculture based industries imposes its own set of stress factors and development needs on the people. These factors affecting development are many and complex in nature, quite beyond the scope of this paper, and so we limit ourselves to the key factors that merge with our shared experience.

Rural people and communities may be divided into three categories based on power, resource ownership and attitudes. These are:

- Surplus communities: People who are already powerful and owners of large resources. Often members of such communities operate on acquisitive principles. They tend to corner available resources, goods and services.
- Subsistence communities: They tend to be as self sufficient as possible, non-aggressive, content with existing situations and generally resistant to change. They may have traditional ownership of resources which can easily be challenged by the surplus communities.

- Ecological refugees: People who have been removed from the subsistence group due to acquisition of resources by the surplus communities and the government policies, and are forced to move out to new areas.

The process of rural development involves an interaction between these three groups of people having limited resources, with social and political institutions acting as moderators. In India and Nepal, these 3 groups, in their interrelations are creating conditions of rural unsustainability. Stress points in which unsustainable development is occurring may be delineated as follows:

1. The vast majority of people of India and Nepal live below the poverty line, which is generally accepted as around US $ 300 (IC Rs 11500) per annum. These poverty levels are mainly a product of resource crunch and conflict.

- Land, specially irrigated land, is severely restricted in nature and ownership often follows uneconomic trends. Most rural people are marginal cultivators owning less than a half acre of land. Subsistence in these cases is very vulnerable to external pressures and ecological disturbances.
- The conflict over land resources is further intensified by declining productivity due to deforestation, land erosion and unsustainable agricultural practices.
- The subsistence people and ecological refugees are denied food security due to the lack of access to resources. This generates a tight rope situation where any

disturbance to the normal cycle can lead to crisis in the form of famine or epidemic.

- Surplus communities tend to corner the bulk of goods and services and infrastructures in the area, thereby increasing disparity between the groups. Supplementary factors such as illiteracy and lack of knowledge tend to intensify the problem. This is specially true of sensitive hill and arid zones.

2. The resources channeled through government development agencies are also very important factors. Most decisions in utilization of these resources is in the hands of the surplus-communities. Government, which is the largest development agency in both India and Nepal, generally goes through a process of planning, implementation and monitoring of development programs, without involving the beneficiaries of the program. If a program like welfare housing is to be taken up in a subsistence area ,the planning and decision making as to who is to get the houses , where they are to be situated, what design is to be followed etc. is all done by the politicians and bureaucrats. The beneficiary's only involvement is to move into the house after it is built. Obviously this leads to alienation from the asset created , its cost and its maintenance. Many development programs suffer from this top down, donor driven approach, which may be well intentioned but cannot succeed due to lack of ownership of the process by the target community.

3. Development goods and services also tend to be inequitably distributed between urban and rural sectors through a similar surplus-subsistence relationship on the sector level. Energy resources, education and health resources and infrastructural resources are concentrated in the urban areas, increasing pressure on the rural poor.

4. Ecological pressure is at a critical level due to a mix of factors-

- Depletion of forest resources due to conflict over timber and fuel wood , non-timber forest produce, and land for agriculture.
- Depletion of water resources due to less ground water availability, and pollution of existing sources by chemical based agriculture, industry effluent and new consumer practices.
- Depletion of biodiversity due to scarcity of resources on which various food cycles are based.

5. Rural to urban migration : This phenomenon is again a product of resource crunch. Firstly, the availability of goods and services in the urban sector ,as advertised by the media, is a strong attraction to resource starved subsistence people. Secondly, economic need drives people to cities where money can be earn through wage labor and small business. Finally, the overall development policy of the state tends to create the phenomenon of ecological refugees. In this context, large energy generation projects and

government incentives to industries in rural areas deprive the subsistence people of land and resources forcing them to migrate to urban areas.

6. The critical situation affects vulnerable sections of society in far greater scale. Tribal people, women and children may be cited as three most vulnerable segments of rural societies. Women, despite forming fifty percent of population and constituting a high percentage of the agricultural work force, have remained dissociated from the decision making. Their marginalization tends to be aggravated by illiteracy and isolation from the main stream. In a similar fashion tribal communities are also being marginalized and alienated.

All this in turn revolves around the access to resource and ensuring conflict between people and communities. To tackle these problems and to reduce levels of conflict, several options may be examined.

- Comprehensive assessment of natural resources, ownership patterns and of potential utilization through a participative process at micro and macro levels. The resultant data can be utilized to plan for secure livelihood.
- Participatory planning and decision making processes to be implemented at different levels of society to ensure equitable distribution in the provision of development goods and services, as with a comprehensive horticulture program.

- Focused interventions designed to empower vulnerable groups and especially women. Using the methodology of participatory planning, implementation and monitoring through flexible formalized structures, empowerment of concerned communities can be ensured.
- Taking the entire watershed as a base for community level planning, a sustainable development process can be implemented. The watershed is a logical unit for micro level planning because of the integrated nature of resources and communities within the boundaries of a watershed, and also because of the extreme vulnerability of watersheds especially in the hill areas of Nepal. The proposal gives a brief introduction of present institutional arrangements and government policies in rural development in Nepal. It is intended to seek for an alternate more efficient institutional arrangement for successful identification, implementation, operation, maintenance and monitoring of development projects in the micro watersheds of Nepal.

Taking the above approaches, it is envisaged that many of the critical levels of unsustainability can be alleviated, while ensuring empowerment of the rural communities to meet their needs and to leave sufficient resources to meet the needs of the future generations.

Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Project Title:
Sustainable Development of Horticulture in Orissa

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Sustainable Development of Horticulture in Orissa

In the common Statement of the Problem for the rural development sector, sustainability and problems of unsustainability are defined in environmental, economic and social terms. It is the endeavor here to locate a sustainable path for development of horticulture in environmental, economic and social terms for Orissa.

1. The sustainability path: possibilities

It is not my intention to put forth the case of sustainable horticulture development in a grand design, indicating its primacy over other approaches. It is attempted here to project sustainable horticulture development as an alternative means to increase returns from some fixed inputs like land for a better living. Horticulture, to be sustainable, has to be economically viable, environment friendly and socially just. Following is my idea of how to achieve sustainable horticulture development in the state of Orissa.

To optimise economic return from available land: Orissa has a land area of about 15.5 million hectares of which only 40.6% (6.3 million hectares) is under cultivation. 52% of operational holdings account for only 17.5% of the cultivable areas and the average size of land parcels is less than one hectare. Horticulture usually is a cash crop cultivation and such fragmented land holdings underscores the necessity of adopting appropriate technology to maximise return.

Secondly, for Orissa it also requires co-operative farming so that basic inputs and infrastructure like water and mechanisation can be utilised on a least-cost basis.

Thirdly, the state needs to adopt to consolidate holdings in an effective manner so as to arrest further fragmentation of land.

The basic idea is that horticulture has to be made economically viable, which means that farmers can produce enough for self-sufficiency. Economic viability is measured not only in terms of direct farm produce (yield) but also in terms of functions such as conserving resources and minimising risks.

To make horticultural practice suitable in each agro-climatic zone: The behaviour of agro-eco systems can be described by four system properties: productivity, sustainability, stability and equitability.These properties are easy to define but difficult to measure.

Horticulture is sustainable if it is ecologically sound, which means the quality of natural resources is maintained and the vitality of the entire agro-eco system from humans, crops and animals to soils and organisms is enhanced.

Agriculture, horticulture and soil-conservation activities are implemented and monitored by the Agriculture Department. But co-ordinated efforts to arrange healthy growth of each on the strength of the others has eluded the state. This situation has been corrected now by

adoption of "Agriculture Policy, (Orissa) 1996" during the current year. Detailed support to farmers and entrepreneurs is outlined in the new policy and horticulture has been accorded the status of an industry. This will encourage more coordinated planning and development of horticulture on a suitable agro-climatic zone basis.

To allow access by all to available resources: To make horticulture sustainable, it has to be socially just which means that resources and powers are distributed in such a way that the basic needs of all members of rural communities are met and their rights to land use, adequate capital, technical assistance and market opportunities are assured.

The 1996 Agriculture Policy makes provisions to bridge the gap between individual needs and government targets. For example, an entrepreneur may be interested in developing a model farm but he may not own land or have adequate capital to purchase the same from private land market. Now the new policy provides for leasing government land for such purposes. Even government-owned farms have been opened for private enterpreneurship. It encourages individual and collective initiative and enterpreneurship not only with respect to cultivation but also with respect to storage, marketing and processing of produce.

The help of financing institutions has been assured in the new policy as well.

It is expected that such incentives and encouragements can ease bureaucratic procedure and motivate people to take up horticulture development.

2. Objective

The objective of this proposal is to design a comprehensive programme of sustainable horticulture development in three villages of Orissa to be selected from three different agro climatic zones. The programme shall address the following:

a) motivate people to take up high value horticulture crops,

b) train people in sustainable horticulture,

c) prepare a detailed package of practices to supplement village efforts,

d) make available best quality inputs including seeds, plants and fertiliser directly to the villages,

e) arrange regular monitoring and counselling through extension,

f) arrange proper postharvest management and organise marketing and processing of products,

g) organise necessary credit mechanisms to allow villagers to make investments in sustainable horticulture,

h) finally, keep a blueprint of the yield on the same land earlier and after such practices.

In this entire effort participation of the farming community will determine implementation.

The above proposal is designed to make horticulture sustainable by making it economically sound, agro-climatically suitable and socially equitable.

3. Barriers to sustainable development of horticulture in Orissa

Orissa is a predominantly agricultural economy. About 87% of the people live in rural areas and more than 80% depend on agriculture. Only 40.6% of the area is under cultivation. A majority of holdings are small and marginal. 52% of the operational holdings enjoy only 17.5% of the cultivable area with the average holding being less than one hectare. Thus the incidence of poverty is very high. In 1987-88 whereas 29.9% people were below poverty line in the country, it was as high as 44.7% in Orissa.

Agriculture as a whole, and horticulture in particular, has not achieved the desired level of growth. The development attention accorded in this sector has gone to agriculture. The so-called Green Revolution could reach only the privileged few, those who had access to high cost external inputs. We have not achieved any break-through in improving the quality of life of resource-poor farmers who have no or little access to the external inputs. In essence, the reasons behind such low growth are: fragmented land ownership, unprofitable land use pattern, the high concentration of marginal farmers unable to use the high external inputs and illicit cutting of forests leading to soil erosion and shifting cultivation. As to this last factor, illicit forest-cutting is in part a result of the inability of resource-poor farmers to assure a basic livelihood for their families and, therefore, resort to unsustainable practices to survive.

The following paragraphs offer brief evidence of each of these barriers to sustainable horticulture development.

3.1 Land holding pattern

Total operational holdings: 35,86,000

Total cultivated area: 63,04,000 hectares

Category	% of holding	Average size of holding	Area Owned (%)
A	52	below 1 hectare	17.5
B	25.4	1.00-1.99 hectare	24.2
C	16.3	2.00-3.99 hectares	29.8
D	5.7	4.00-9.99 hectares	22.2
E	0.6	10.00 & above	6.3

Source: Techno-Economic Feasibility Study for Development of Horticulture in Orissa, INCON Pvt. Ltd.

3.2 Types of land

Following is the distribution of different types of land in Orissa.

Highland	46.2%
Mediumland	30.0%
Lowland	23.8%

Source: Techno-Economic Feasibility Study for Development of Horticulture in Orissa, INCON Pvt. Ltd.

Lowlands are concentrated in coastal districts which are otherwise developed. The major parts of inland districts have arid and less productive farms and suffer from poverty of various forms and degrees.

3.3 Types of soil

Fertile laterite and alluvial soils are concentrated in the coastal districts, whereas infertile red and yellow soils constitute the bulk of the area of remaining districts making

agricultural growth even more uneven. As many as seven out of old thirteen districts come under the eastern Ghat and plateau zones making it difficult for horticultural growth in view of the hilly terrain and large-scale shifting and podu cultivation.

3.4 Irrigation scenario

According to 1990-91 statistics (Agricultural Statistics: Government of Ores, 1991),Ores has about 30% of its land under irrigation. Cropping intensity has moved from 106.05 in 1960-61 to 155 in 1993-94. This rate has not been able to match population growth.

3.5 Cropping pattern

Name of crop	% area coverage in 1980-81	% area coverage in 1993-94
Cereals	59.25	52.40
Pulses	19.73	21.84
Oil seeds	8.42	11.15
Fibbers	1.14	0.68
Others (including horticulture)	11.46	13.93

Source: Agricultural Statistics: Government of Orissa, 1991

The above table indicates that shift in favour of horticulture is not significant.

3.6 Productivity: (Quintals per hectare)

Name of crop	1960-61	1993-94
Food grains	9.06	11.4
Vegetables	57.04	82.61
Condiments and spices	10.30	12.14

Source: Agricultural Statistics: Government of Orissa, 1991

Comparative productivity of horticultural crops in India and Orissa is as follows:

Average yield (tonne/hectare) 1990-91

		India	Orissa
Fruits and nuts	Mango	8.5	5.5
	Banana	18.7	9.2
	Papaya	23.0	11.0
Vegetable	Potato	16.2	9.5
	Onion	16.6	7.1
	Tomato	16.6	11.6
Spices	Corriander	0.632	0.485
	Turmeric	2.956	2.458
	Ginger	2.790	1.612

Source: Agricultural Statistics: Government of Orissa, 1991

As these tables show, productivity in Orissa has not matched the growth rate achieved in other parts of the country. Though productivity in respect of vegetables seems to be on the rise, the rate of such rise is not comparable to that of other states.

3.7 Trends in horticulture

The total area under horticulture has increased from about 120,000 hectares in 1977-78 to about 190,000 hectares in 1993-94. This does not include vegetables and spices which also showed similar trends during the said period. This also does not include cashewnut which is handled by the Soil Conservation Department. While the area under horticulture is on the

increase, productivity has not enjoyed a commensurate rise, thereby making the average yield still much below expectation.

3.8 Rainfall pattern

Orissa experiences an average of 1,503 mm rainfall annually, almost equally distributed over the entire area. But the problem is that it is spread over only 73.4 rainy-days on an average. With irrigation being meagre, the number of rainy-days limited and the concentrated character of precipitation causing both flood and drought, sustainable planning for horticulture becomes a very difficult job.

3.9 Equitable access to inputs

3.9.1 In 1990-91, consumption of fertiliser per hectare of gross cropped area was 20.9 kgs as against an all-India average of 72.4 kgs, Andhra Pradesh average of 133.2 kgs and West Bengal average of 90.3 kgs.

3.9.2 Percentage of villages electrified in 1990-91 was 69.8% as against 84.2% for all of India.

3.9.3 Per capita consumption of power in the agricultural sector in 1989-90 was 5.4 kwh compared with an all India average of 53.7 kwh and an Andhra Pradesh average of 85.1 kwh.

3.9.4 Per capita income at 1980-81 prices was as low as Rs. 1493 in 1988-89 against Rs. 2105 for all of India.

In a nutshell, the constraints faced in development of sustainable horticulture can be summarised as follows:

a. Low productivity of fruits and vegetables,

b. Fruit crops mainly grown under rainfed conditions suffer from severe water-stress during dry periods,

c. Inadequate supply of genuine and suitable planting materials (seeds, seedlings, grafts),

d. Poor management practices of orchards,

e. Lack of adequate postharvest management facilities,

f. Lack of arterial roads and proper transport facilities in several inland districts ,

g. Lack of cold-storages and required godowns (warehouses),

h. Predominant use of local varieties of vegetable seeds,

i. Lack of compact-area practices in plantation,

j. Inadequate field extension machinery and inadequate research support for demonstration of modern horticulture technology ,

k. Lack of proper data-base for horticulture.

The above identified constraints are only illustrative and not exhaustive .

4. How to overcome the barriers

Agriculture and, in particular, horticulture has been taken up by the present Government (which came to power last year) for special attention. There has to be strong political will for the success of any programme in the state. The political committment to agriculture and horticulture is amply demonstrated by the fact that "Agriculture Policy (Orissa) 1996" has already been enunciated and has been in operation from April 1996. As already discussed earlier, co-ordinated efforts among related sectors was lacking.Through this policy, such barriers as identified above are being tackled effectively .The following are additional

suggestions as to how these barriers can be overcome. These suggestions are consistent with the new policy and can be readily incorporated in a strategy for making horticulture development sustainable.

4.1 Compact area approach

Small farmers should be encouraged to take up horticulture crops in compact areas of more than ten hectares. For this goal to be realised incentives in the form of input subsidies will need to be given. Right now there are some subsidies but a comprehensive incentive strategy needs to be adopted. This has been provided in the policy. This action will help to reverse the process of fragmentation.

4.1.1 Giving land on lease to participating farmers could also be used to raise the attractiveness of the compact area approach.

4.1.2 Educated, unemployed youths should be encouraged to participate in mushroom and vegetable cultivation ,which give quick returns. This would mitigate the unemployment problem to some extent.

4.1.3 Private enterpreneurs are being encouraged under the new policy to adopt government farms on lease for the purpose of providing nursery seedlings to solve the problem of quality planting materials. This could be demonstrated through an Agro-Park which is being established near Bhubaneswar for which an MOU has been signed between the Government. and local enterpreneurs .

4.1.4 Off-season vegetable cultivation should be taken up on a large scale for which there is ample scope in Orissa.

4.2 Adopting suitable technologies

A new organisation named Agriculture Promotion and Investment Corporation Ltd. has been created recently to, among other things, spur rapid horticultural development .Under the aegis of this Corporation and the Directorate of Horticulture, a comprehensive plan for sustainable development of horticulture will be prepared. This would make available a "single window system" (all the inputs, technical knowhow and information about marketing and processing would be available at one place) for farmers , enterpreneurs and those in marketing and storage.

4.2.1 Detailed crop planning schedule for different soil types and agro-climatic zones should be taken up as a task in the Comprehensive Plan.

4.2.2 A detailed package of sustainable cropping practices should be made available to farmers .

4.2.3 Continuous training programmes at the Block level will go a long way toward dissemination of technical knowledge at the grass-roots level.

4.2.4 To make the transfer of information and techniques continuous, weekly counselling centres along the lines of Krishi Sahayak Kendras should be organised at the Block level.

4.2.5 Community nurseries should be established at the Block level to foster the development of improved vegetable seedlings. Such nurseries should also be created to cater to the needs of fruit farmers .

4.2.6 Tissue-culture laboratories and greenhouses should further supplement the said efforts. Under the policy there is lot of incentives for the same .

4.3 Equitable access to resources

4.3.1 Credit will be made available by both Commercial and Co-operative Banks.Although an infrastructure is in place, its functioning has to be strengthened. This could be achieved by integrated efforts of government agencies and financial institutions through grassroots level planning.

4.3.2 Regional Marketing Societies need to be strengthened and the Mandy system operationalised to protect farmers against unscrupulous middle-men.

4.3.3 Necessary grading and packing facilities must be established to assure high quality produce.

4.3.4 Cold-storage chains and de-humidifier godowns (warehouses) are needed to stock vegetables , potatoes and onions for lean seasons and will protect farmers from having to resort to distress sales.

4.3.5 Inputs like manure and fertiliser need to be delivered directly to each village.

4.4 Organisational Reforms

To achieve the goal of sustainable horticulture development organizational actions must be strengthened.

4.4.1 The Directorate of Horticulture has to be provided with adequate extension officials to take care of the people's needs at the Block and Gram Panchayat levels.

4.4.2 The State Agriculture University needs to be supported to conduct continuous research work on sustainable horticulture.

4.4.3 Information and training have to be provided continuously. Field trips for farmers to successful examples is a must.

4.4.4 Departmental farms have to be up-graded to commercial scale both to meet the demands of quality planting materials and also to serve as model demonstration centres .

5. Project Methodology

The present proposal will be developed into a Project Report which will address details and will also take care of new aspects. The design will be tested in three villages in three different agro-climatic zones and results will be reported in the final Project Report as Case-Studies. It should be noted that the the said Case Studies will focus only on the impact of vegetable cultivation. This is mainly because vegetables are short-term crops and results of the proposed interventions will be available before presentation of final Project Report.

5.1 Selection criteria for identifying villages for case study

5.1.1 There are three distinct zones in Orissa viz. coastal, tribal and arid/drought prone.One village from each of these areas will be selected.

5.1.2 The villages where vegetable cultivation is being carried out to some extent will be chosen so that the results of earlier cultivation and the guided cultivation can be compared.

5.1.3 The selected villages should also have suitable types of soil to enable experimentation of hybrid and high yielding vegetable seeds.

5.2 Assessment of effectiveness of the strategy for sustainable horticulture development

5.2.1 The yield before and after the interventions will be compared.

5.2.2 Through participatory rural appraisal, motivation levels of farmers will be gauged.

5.2.3 The effectiveness of training to the farmers and their initiative to utilise up-to-date technology will be assessed.

5.2.4 The demonostration effect of such improved practices in the surrounding areas will also be assessed over a period of time by involving farmers of the surrounding areas.

5.2.5 Lastly, the change in economic status of farmers and its impact on social equity will be evaluated.

The barriers to sustainable horticulture development are not insurmountable. At the same time, they cannot be overcome over-night. Sustained and strong political will, sincere implementation on the part of bureaucracy and enthusiasm on the part of farmers and enterpreneurs are all essential to making the plan of sustainable development of horticulture successful.

Phase II Report

ENVIRONMENTAL PROTECTION

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Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Group Statement
Environmental Protection Issues

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August 1996

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Industrial and Urban Waste Impacts

Since the industrial revolution and the rapid urbanisation of societies, there has been increasing pressure on natural resources. The ways in which these resources are being depleted, in itself, sometimes account for the stress on the biosphere which supports all life systems, including that of human beings. The production processes by which natural resources are converted into final usable products also put pressure on the environment. The biosphere in which we live is the only available sink for the by-products of production and consumption.

In India and other developing countries, the last few decades have seen a tremendous rise in the use of environmental resources as a result of increased production. However, while increasing production, such rapid depletion has also led to adverse social and environmental consequence. Moreover, such rapid depletion of resources ignores the fact that environment is a finite closed system. Production planners have not been required to take responsibility for the generation and management of wastes. There has been no perceived necessity to manage this aspect and many industries/economies are not willing to allow it to eat into their growth/consumption patterns. The urban lifestyles emerging around industrial regions are leading to rapid growth in per capita consumption, often fed by affluence. But increasing consumption is in turn leading to more demand for goods and services, which necessitate more production and result in mounting pollution, wasted resource depletion.

While in developing nations like India, rapid growth in population is mainly leading to increased overall consumption, in developed countries like the US, high consumption per capita itself accounts for excessive use of natural resources. Both were depleting environmental resources faster than they can be replenished and also generating wastes in the process that exceed the local, regional and even global carrying capacities. Increasingly, the environment has less to give while economies seek to take more and more. Human activities are beginning to leave a permanent imprint on the environment. In other words, effects on environment are becoming irreversible.

Basically, all human activities lead to some residual materials which are not of immediate use. When consumption increases and the density of consumers in a region grows geometrically, these residues become significant burdens for the environment. One of the greatest footprints modern human society is leaving on the environment is waste. Wastes have several undesirable forms and impacts:

a. Degenerating quality of air and water - both air and water pollution have critical impacts on human health and the environment.

b. Spread of diseases and ailments among humans and the emergence of new diseases and subsequent stress on healthcare systems are also a consequence of mounting pollution.

c. Degradation and contamination of soils and changing soil chemistry are leading to agricultural problems.

d. Other problems with global implications such as acid rain, global warming, upper atmosphere ozone depletion are expanding the problem to systemic levels.

The following are some reasons why urban and industrial wastes are poorly managed and as a result have adverse impacts on nature:

a. rapid population growth increases demands on environment, often beyond local ecological carrying capacities.

b. rapid urbanisation accompanied by rising demands for civic amenities lead to increased capacities to pollute with little regard for ecological.

c. The spread of poverty in urban areas due to the uneven nature of industrial development threatens livelihoods while being used to rationalise environmental degradation.

d. financial crises also are used to justify trading environmental quality for economic growth.

e. improper siting of industries and inappropriate disposal sites for urban and industrial wastes especially in developing nations lead to concentrated pollution that overloads local natural carrying capacities.

f. inadequate laws and trade policies and lax enforcement mechanisms to check pollution of all kinds make waste and air pollution “normal”.

g. lack of environmental and health awareness mean that individuals and firms make decisions without a clever understanding of impacts of their actions.

h. inappropriate and obsolete waste disposal technologies result in persisting problems of waste and pollution that become increasingly expensive to correct.

If the present patterns of waste generation and management continue, further worsened by improper policies, not only will environmental resources be depleted, they will also be degraded. Therefore, by the turn of the century, the very quality, and quantity of natural resources which will be available for **future** generations will fail to **sustain** even the **present** quality of life.

We can rectify some of these problems by abandoning present levels of development. But that is not possible. If economies want to sustain present rates of development in the future, they will have to take steps to minimise the impacts felt by the environment., so that the damages are not irreversible and the wastes going back to the environment do not exceed the carrying capacities of the environment.

Another issue of concern is that the current accounting systems do not incorporate the environmental costs that are involved. It is important that these costs are reflected in the decision making process and that environmental impacts are assessed. Basing development and environmental policies on a comparison of benefits and costs, and on careful macroeconomic analyses, will strengthen environmental protection and also lead to rising and sustainable levels of welfare. Diverse problems in the field of waste management require that environmental protection must adopt a multi-sectoral approach which would not concentrate only on a single facet of the problem.

Program in Energy, Environment, Resources and Sustainability (PEERS)

Project Report - Phase II

Project Title:
Issues in Urban Solid Waste Management

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August 1996

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Issues in Urban Solid Waste Management.

Over the past two decades there have been tremendous developments in the size f many towns/cities in the developing countries, including in India. This has been caused partly by a large influx of people from the surrounding countryside, coming in search of employment, and partly due to population growth. This migration of people from rural to urban areas, puts tremendous pressure on the already strained civic amenities of the urban bodies.

A large number of towns and cities suffer from improper solid waste management. Some of the symptoms of improper waste management are:

a) Garbage dumped in streets leading to spread of infectious diseases such as dysentery, worms, enteritis, typhoid fever, hepatitis and cholera.

b) Animals such as cows, goats, dogs, chicken feeding on the solid wastes and thus making direct contact with the contaminated matter.

c) Garbage leading to dust in the streets leading to lung infections.

d) Pungent and foul odour especially during the summer seasons.

e) Unsightly appearance of towns.

f) Garbage being carried away by rain water to different places causing spread of contamination.

Waste handling can be split into the following :

i) Collection of garbage.

ii) Sorting of garbage.

iii) Transportation.

iv) Disposal and recycling of solid wastes.

Ensuring public hygiene and sanitation is the primary responsibility of an urban local body, i.e. the town or the city municipality. These local bodies face several bottlenecks in waste handling resulting in the various problems listed above .

It has been observed that solid wastes do not get collected properly. In a typical case only 70 - 80 % of the waste generated on a day gets lifted. Categorisation of wastes is a very rare phenomenon and the only sorting which normally goes on is done by the rag pickers.

Since the garbage is not sorted depending on its composition no scientific disposal of these wastes is possible. The only disposal which is carried out is based on the maxim 'Out of sight out of mind' Whatever garbage that gets collected is just removed and dumped in a unoccupied place .

From the above it is evident that the wastes are mismanaged at every step . As the size of a city/town grows the solid waste scenario goes on worsening resulting in contamination of the soil, air and water and thus leading to adverse impact on environment which is beyond its carrying capacity. This may give rise to serious sanitation and public health problems.

Thus if remedial actions are not taken the citizens of these cities will have to face severally degraded surroundings which would have an undesirable impact on the health and efficiency of the citizens.

There are several factors which are accentuating the problem of waste .

1/ Rapid urbanisation due to growth in population and migration .

2/ Un-regulated and unplanned growth of cities.

3/ Lack of awareness among the public about sanitation and public hygiene .

4/ Financial resource crunch of the local municipal bodies.

5/ Reluctance on the part of the government to take punitive action against the persons who do not follow the rules governing the solid waste disposal .

6/ Inappropriate waste handling and waste disposal technologies.

7/ Failure to adopt systems approach for waste management .

8/ Resistance to privatisation of some of the waste management activities .

Generally attempts to solve the problem of waste handling, have been confined to introduction of certain modern technologies in the waste handling and disposal process. . Direct adoption of these technologies by the developing countries appear attractive but in all cases it may not succeed. Mere introduction of modern technology will not be a panacea for all ills of the wastes, as there are several other factors which need to be attended to simultaneously. Secondly in problems of waste management there are no universal solutions, and every city/town needs a system tailor-made to its own physical and economic environment.

A systems approach would thus be necessary to tackle the problems of urban solid wastes. Such a systems approach would require:

--policies to be formulated

--institutional arrangements to be created

--implementation of better technologies and procedures

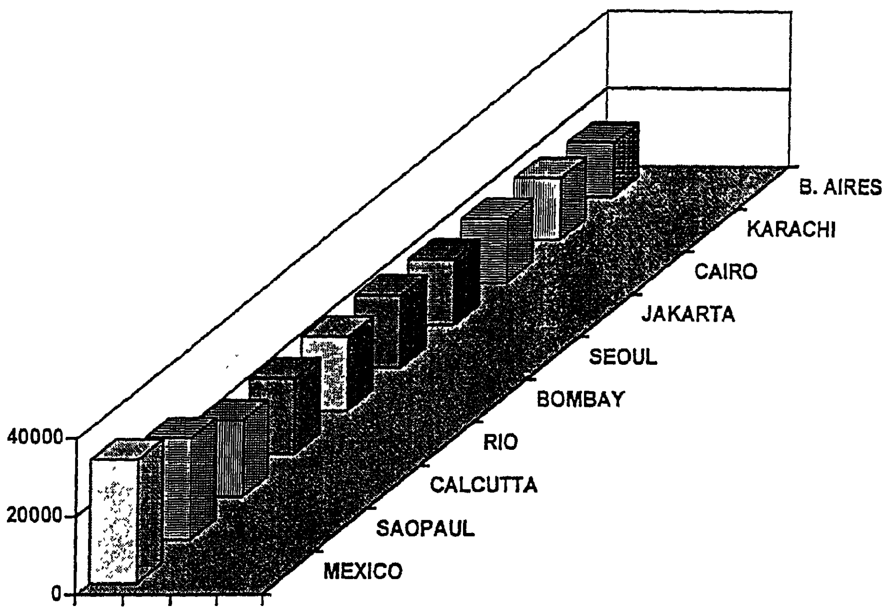
--finding financial resources for implementation of the improvements suggested

This study would focus on all the above mentioned aspects and also attempt to design a workable project for a city municipality for effectively handling solid wastes.

Solid Wastes - the Existing Scenario

The World Bank, in a recent development report has said that by the year 2000 , of 52 cities that will have population in excess of 5 million, 40 will be in the developing countries. It has been projected that the population in some of the major cities in the developing world will be as follows.

POPULATION OF DEVELOPING WORLD CITIES IN 2000



A large number cities in the developing countries are notorious for their squalor, poor housing, inadequate sanitation, insufficient civic amenities. All this is likely to get worse, especially when the population explosion takes place (this is underway). The urban development programmes are unbalanced with bias towards city centres, ring

roads, airports, and all the usual status symbols. This benefits only a small elite. Slum clearance, adequate housing, pure drinking water, sanitation, waste management come much further down the priority list. The cities are posing a tremendous challenge to the planners and administrators, even to maintain a minimum of civilized standards.

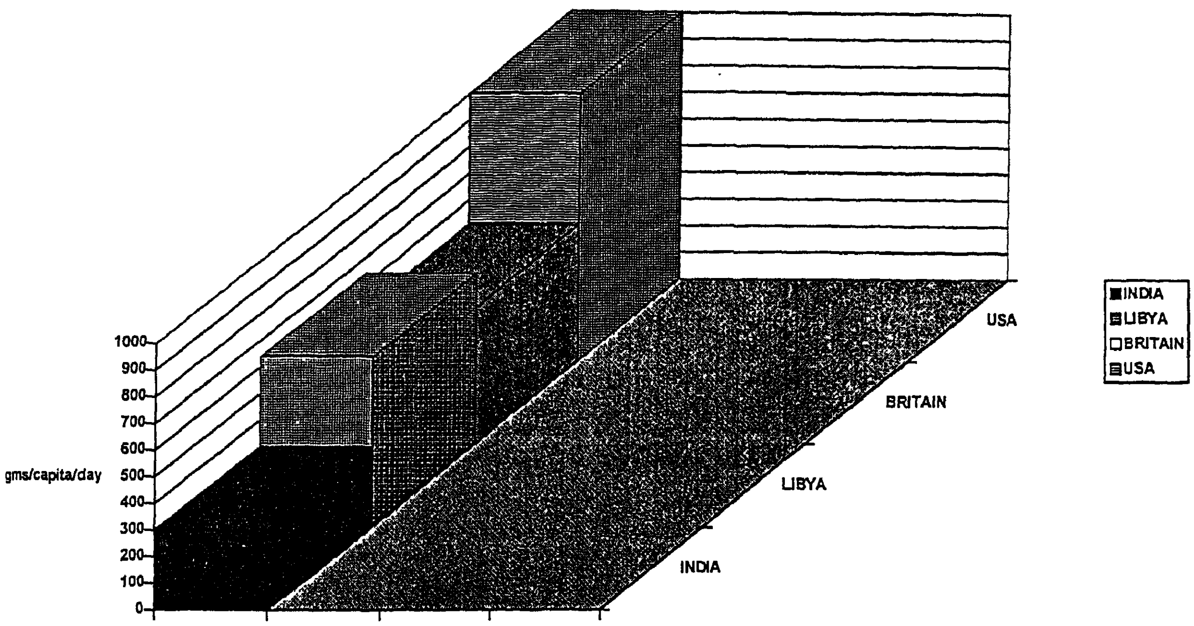
Urban solid wastes are extremely heterogeneous and may be described as follows:

REFUSE MATERIAL BY KIND, COMPOSITION AND SOURCES

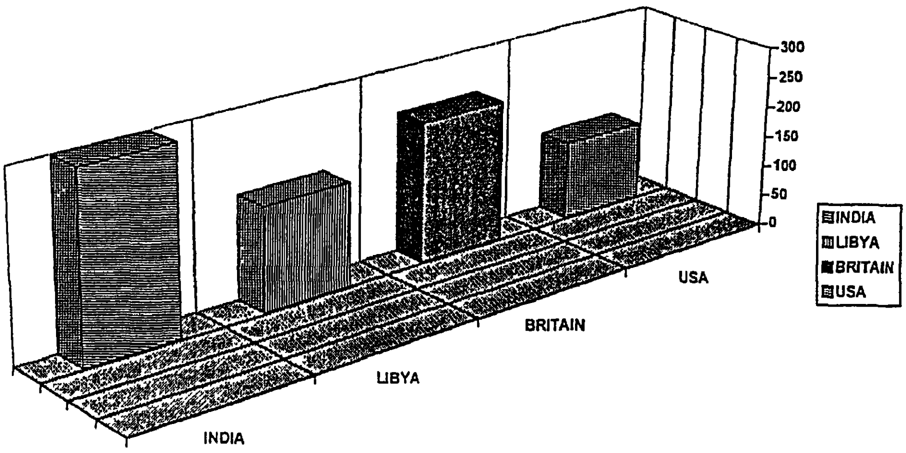
KIND	COMPOSITION	SOURCES
garbage	wastes from preparation, cooking, and serving of food;market wastes;wastes from handling, storage, and sale of produce	households,restaurants institutions,stores.markets
rubbish	combustible:paper,cartons,boxes,barrels,wood,tree leaves and twigs,dunnage non-combustible:tin cans,metals,dirt,glass crockery	
ashes	residue from fires used for cooking and heating and from on site incineration	
street refuse	sweepings, dirt,leaves,contents of litter and receptacles	
dead animals	cats,dogs,cows,buffaloes	streets,sidewalks,vacant lots
industrial waste	food processing wastes,boilers,lumber scraps,metal scraps,shavings	factories, plants
demolition wastes	lumber,pipes,brick,masonary, and construction material and debris	demolition and construction sites
special wastes	hazardous solids and liquids, pathological wastes	hospitals,industry,hotels
sewage treatment wastes	solids from coarse screening and from grit chambers, and septic tanks	sewage treamment plants, and septic tanks

Composition of waste.

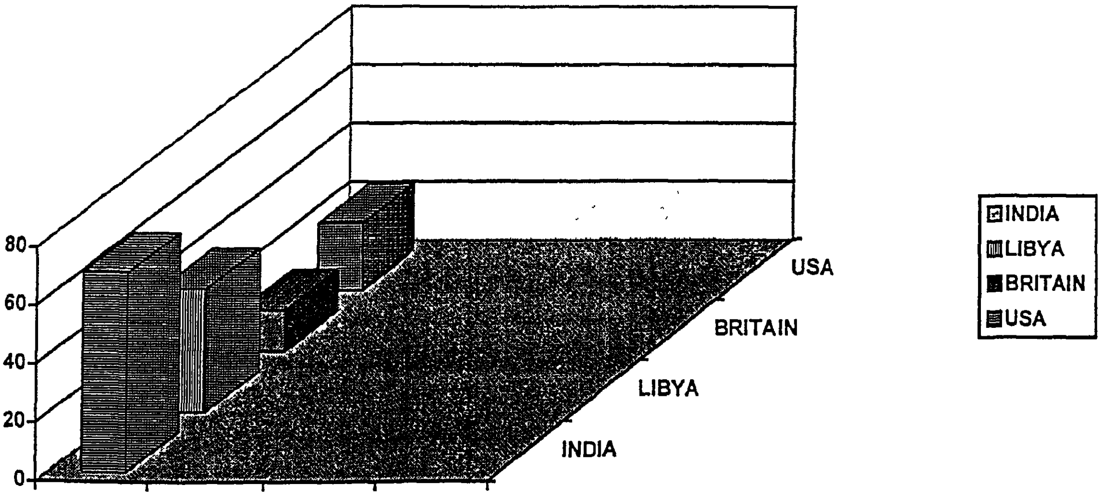
The following diagram indicates the contrasts in constitution and rate of generation of solid waste in various parts the world.


REFUSE VARIATIONS WORLD WIDE

Quantities of wastes are invariably lower in developing countries because of the low prosperity and consumption as well as extensive scavenging and salvage by beggars and rag pickers, and the very poor. Densities of waste are much higher because of the absence of paper, plastic, and a much greater concentration of the putrescible matter. Refuse is and has always been a keen pointer to the socio-economic conditions of those who create it.

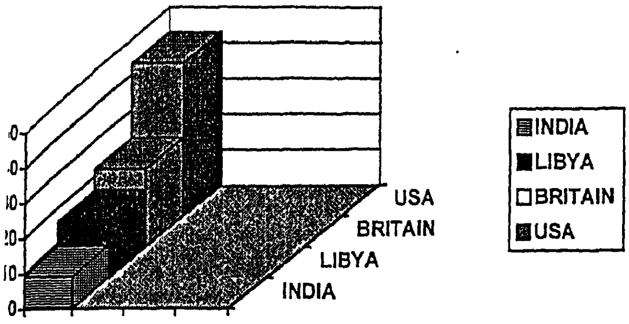


DENSITY in kg/cu metres



VEGETABLE CONTENT %

PAPER %



The four main pillars of any solid waste management system are:

I) storage at or near the point of generation.

ii) collection and transportation of waste.

iii) street cleansing.

iv) disposal of waste.

torage of waste at the point of generation.

In most of the developed countries waste is collected by the door to door method. here are a multitude of practices being followed but these can broadly classified as ollows:

1/ kerbside collection

2/ drop off method

3/ buy back method

In the kerbside collection method the residents of a place collect the garbage in a container provided for the purpose in their houses (multiple containers are also in use in some places in order to sort the garbage). In most case it gets sorted out at the source itself. This garbage thus collected and sorted is then dropped in different bins kept at the kerbside. From the kerbside the garbage is collected by the mobile collectors periodically.

In the drop off method the garbage is taken by individuals to the collection/disposal sites and deposited into the designated containers. In the buy-back centres the processing facility pays for the delivery and transfer of ownership to the facility of the source separated material, for the purpose of recycling and or depositing.

In developing countries only a small part of the garbage gets collected by the door to door collection method. For the rest, a variety of bulk collection methods are used. But there is a wide spectrum of techniques and degrees of mechanisation employed. At the lowest end of the scale are the primitive man-handling systems whereas in some cities waste is collected, transported, and transferred over and over again using mechanical/hydraulic devices, before it finally reaches its final place of deposit. It is common to find the use of concrete depots, spun concrete pipe sections, the ubiquitous oil drum, and an infinite variety of mud brick housings and improvised enclosures. When the municipal organisations are weak, the ground storage points become less structural and little more than ground dumps hollowed by long public usage.

Communal collection point is a feature of waste collection in a developing country. It is common to find the communal points being served by teams of collection labourers, using wheeled trolleys or wheel barrows to move waste from household or

smaller satellite dumps to the communal storage points. The relative cost of different modes of garbage collection is shown below:

Systems	Outline	Public part	Relative cost
communal	central bulk collection by refuse vehicles	place refuse in nearest bulk container	100%
kerbside	full access by refuse vehicles to all areas	place refuse in the adjacent kerbside container	110%
kerbside	70% access by refuse vehicle with 30% secondary transfer	place refuse in the adjacent kerbside container	128%
kerbside	30%access by refuse vehicle with 70% secondary transfer	place refuse in the adjacent kerbside container	162%
house to house	100% house to house service	place refuse in individual household container at dwelling entrances	277%

The existing system in developing countries suffers from the following deficiencies:

a) The collection and handling process involves collection from streets to hand carts. The rubbish is then dumped back on to the ground to be repicked up by the rakes and buckets and put into trucks. This results in wastage of labour and waiting time for vehicles, apart from the great health risks to which the workers are constantly exposed.

b) A lack of community containers or an enclosed storage place of proper design for collected street and house wastes. In a typical small city 60% of the total number of collection points are such open heaps. These dumps are invaded by scavengers and animals which scatter the waste. The flies have access to food and the larvae can pupate in the vicinity. During rains much waste is washed into gullies and open drains from where it has to be removed at a very high cost.

Loading and transportation.

The operation of loading the garbage from the kerbside collection point and delivery to the disposal point is more or less fully mechanised in the developed countries. Once the garbage is set out at the kerb, there are several tasks which the collector typically may be required to perform, these include

- sorting recyclables into individual bins or compartments of the truck
- segregating non-recyclables or contaminants from the materials to be loaded.
- returning empty containers or carts to the kerb after loading

A large variety of vehicles and loading devices are in use .These include trailer, bin trucks, closed body trucks, hydraulic side loading trucks, flat bed trucks, compacting trucks, roll-off trucks, hook-lift trucks etc. Of- late multi-use co-collection trucks vehicles are being used. These vehicles can collect different categories of waste simultaneously.

In developing countries like India open trucks, dumpers(tippers), tractor trailers, and animal carts are used for transportation of waste to the disposal point. The loading of garbage from the kerbside onto the vehicle is manual. In a very few cases hydraulic

cranes or loaders are used . The unloading of garbage is mostly mechanical wherever tippers are used. But wherever ordinary lorries are used the unloading is also manual.

The design of these vehicles is unimaginative. In most cities 5-6 tonnes trucks/dumpers, basically designed for carrying building materials, are used for carrying solid wastes. They sometimes do not have any tipping arrangement and loading height is more than 1.86m. The loading operation takes more time than that required by the vehicle to complete a trip to the dumping ground. This results in poor capacity utilisation of the vehicles.

At present 100-200 litres hand cart are mostly used for primary collection. Their design is such that it is necessary to dump the refuse on to the ground before it can be loaded to the truck. This coupled with the high loading height of the transport vehicle makes the system counterproductive both from the labour as well as vehicle utilisation point of view. The loading time for a 5-6 ton truck is 1.5 to 2 hrs. The result is fewer trips and a higher unit cost of collection and transportation.

An indication of the productivity levels of various waste collection systems can be had from the following table.

	System	labour reqmt	volume cu.m	trips/day	tons /day
	manual labour	1 labour	.20	5	0.2
	power tiller	1driver 1 loaders	1.0	6	1.2
c	bullock cart	1 driver 2 loaders	4	4	3.2
d	tractor trailer	1 driver 4 loaders	8	8	8
e	tipper-truck	1 driver 4 loaders	10	10	10
	compacter	1 driver 6 loaders	20	10	20

Street cleansing.

Street cleansing is directly linked to the efficiency of garbage lifting from the kerbside collection points. In developed countries it is not a problem as most of the garbage is in closed containers and it does not overflow onto the road ,and littering is very uncommon. However street cleansing assumes significant importance in case of developing countries. Street sweeping and litter prevention, a subject that appears to be

such a mundane and unskilled operation hardly worthy of lofty professional study, must in fact receive considerable attention. Following the general trend, mechanical street sweeping, even if the investments can be afforded, is only possible in those parts of developing cities - even rich ones - where well engineered roads, channels, and kerbs exist and some form of disciplined parking laws are enforced. A general lack of discipline in clearing backlog debris adds to the problem and, by and large, except for the rich and the best organised , mechanical sweeping is a minority solution. For the rest it is back to manual sweeping with broom, bucket and a barrow.

Even prosperous and spotless Singapore keeps its streets clean by a substantial 2000 worker sweeping labour force backed by a 60 - unit mechanical street sweeping fleet. The European road sweeper with his two bin orderly truck and array of brushes perform quite differently from a poorer colleague armed only with a palm farm whisk broom and improvised barrow trolley. An inordinate amount of manpower in developing cities' cleansing services is devouted to street scavenging and this gives rise to very large labour force. A typical city has a sweeper for every 1000 head of population.

The labourers work in gangs. Normally, every worker is assigned a specific area known as a 'beat' .Sweeping of road is carried out by using a short handled broom made out of a bunch of fibres. The sweepings are either taken to the street gullies or collected from road surface by using a flat blade shovel. The material accumulated in gullies is removed by a stout hard push brush. While doing the work the labourer has to bend this strains his back and exposes him to dust. The productivity of this is very low also because it is very difficult to monitor the performance of such a large workforce.

These labourers are exposed to some considerable health hazards. Often without shoes or gloves, rarely provided with protective clothing, these men and women suffer more often from skin and intestinal infection. Add to these health risks all the usual western hazards of cuts, sprains, and traffic accidents and the resulting cocktail is not pleasant to consume. Top this off with poor home conditions, bad sanitation, and primitive washing facilities and the matter becomes worse.

Waste disposal.

Some of the common waste disposal methods adopted by the developing and the developed countries are as listed below:

1) sanitary landfills

2) incineration

3) composting

Sanitary landfills:- Sanitary landfills are usually conducted by depositing refuse in a natural or manmade depression or trench or dumping it at the ground level, compacting it to the smallest practical volume, and conveying it with compacted earth or other material in a systematic and sanitary manner. Before operations begin, a site must be selected and surveyed; geological and hydrological factors evaluated: the site prepared; access roads control grades and drainage provided for; and equipment selected. Well planned and operated landfills have several advantages: they are economical and flexible; they require a small capital investment; they may reclaim otherwise useless lands; they can accept most classes of solid wastes without segregation, thus permitting economies in the collection systems.

Incineration.

An incineration plant, which may be owned either publicly or privately is one in which combustible refuse is reduced to ash by high temperature burning. Refuse from collection trucks is dumped on a charging floor from where it is charged into furnaces where it is burnt under carefully controlled draft, temperature, and conditions of agitation, to ensure complete combustion and the ashes and non-combustible residues are removed for possible salvage of metallic components and subsequent final disposal, usually in a sanitary landfill. Heat recovery may also be practised through generation of steam.

Advantages of incineration include reduction of land requirements of final disposal, relatively small plant size and a fully enclosed operation permitting a strategic location to minimize collection costs. However capital and operating costs to comply with air pollution standards and to produce nuisance standards are high; and it is not a final disposal method.

Composting.

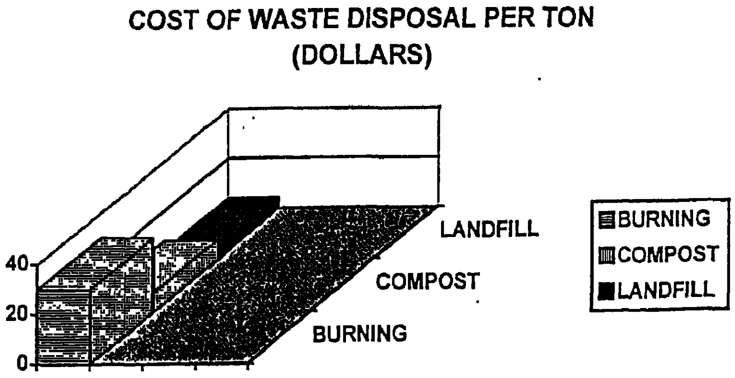
Composting is sometimes defined as a rapid but incomplete decomposition of moist, solid organic matter , in this case , primarily garbage by the use of aerobic micro-organisms under controlled conditions. The result is a sanitary nuisance-free humus like material that can be used as a soil conditioner. Theoretically the advantages are several: the end product has value and is marketable: the site for the plant is comparatively small.

Disposal salvage and reclaimation in developing countries.

The term; 'salvage and reclaimation' covers a number of disposal processes; sorting of refuse, either manually or mechanically, for metals, tins, cans, glass, paper, rags, and other wastes that can be resold; processing the garbage to make it reusable and inert; or to reduce its volume.

All these efforts in the developed countries are preceded by a host of mechanical handling including automatic unloading, movement on conveyor belts, screening, sorting, crushing and reduction.

In developing countries, crude dumping, often at quite unsuitable sites such banks of rivers, is still by far the most common method. e.g. 90% of Asia's waste refuse is dumped. Incineration plants have been experimented with in some cities but they have not met with success. Indian city refuse, having a low calorific value and a high moisture content, and a high quantity of non-combustibles, is not generally suitable for incineration. Apart from a high initial cost, it would need a large quantity of auxiliary fuel.



Major portions of solid wastes collected by the municipal authorities in the cities are presently disposed off by dumping in land or into water. Depending on the manner of landfilling presently practised by different local bodies, they could be categorised as:

a) sanitary landfill

b) controlled tipping in low lying areas, adjacent to the sea for land reclaimation

c) uncontrolled tipping on municipal lands

d) uncontrolled tipping on public/private lands

f) uncontrolled tipping on water

In India two methods of composting are practised by different municipal organisations

1/ pre-treatment or post-treatment windrowing

2/ Indore or Bangalore method of composting of refuse with nightsoil in pits

Relative cost of different methods of composting

	METHODS	CAPACITY TONS/DAY	PRODN COST RS/TON	SALE PRICE RS/TON
1	Indore method manual	1-20	1-30	1-35
2	Windrow compost post-treatment(manual)	3-5	30-40	30
3	Windrow compost post-traeatment(manual)	10-20	20-30	30
4	Windrow composting post-treatment(manual)	50	40	30
5	Post-treatment (semi-mechanical)	200	50	40-50
6	Pre-treatment (mechanical)	200	90	40-50

Recent disposal technologies.

Vermicomposting or vermiculture.

The expression is self explanatory. It implies raising or rearing worms. Vermiculture has been practised for ages for different purposes. The farmer knowingly or unknowingly had realised that if the organic waste was dumped and left by itself it would turn into a high class manure. Later on it was discovered, through scientific studies that this was due to the role played by the earthworms.

In this process the garbage is dumped in designed pits and then earth containing earthworm eggs is added to this pit. The earthworm breeds very fast and colonies of earthworms are formed in three months and the take off stage is reached. Now the earthworms are capable of digesting the garbage and within eight to ten months the lower and the middle layer of the garbage gets converted into manure. The lower layers are removed and fresh garbage is added and the cycle continues. The process sounds simple but requires close and constant supervision.

Methane gasification.

Anaerobic digestion of the municipal solid wastes which is predominantly organic in nature generates methane. The waste can be digested in reactors or in pits covered with soil. Gasification in digesters is efficient and no loss of gas takes place but it is capital intensive. The digestion in pits is not expensive but the collection of gas is not uniform and it is difficult to control the generation. This process is especially suited for the tropical countries as it requires higher temperatures for digestion. This technology of digestion in open pits is still being tried in order to perfect it.

Special issues in waste management typical in the developing countries.

A substantial number of people live in slums and a large number of low income group people have extremely confined living quarters. Under such circumstances it is not possible for these people to keep a dust-bin in their houses. As a result whatever waste is generated and whenever it is generated it is thrown out of the house making the task of the municipal staff very difficult to collect these wastes.

Most of the developing countries are near the equator and are warm tropical countries. As a result the garbage decomposes very fast and necessitates more frequent removals, which is further constrained by the poor financial health of the municipalities. There is a significant proportion of the population eking out their living from the garbage. These people are rag-pickers and are mostly children in the age group of 5-15 years . These rag-pickers sort the garbage for plastics, paper, cardboard, metal, recyclable containers, collect them and sell them to the wholesale dealer in these recyclable goods. There is no charge specifically levied on the citizens for the purpose of waste disposal. The municipalities are expected to meet this expense from their own resources. Most of the smaller municipalities find it difficult to meet even the salaries of their employees not to talk of modernisation of their solid waste management systems. The low literacy rates compound the problem even further. The sense of civic consciousness is low and as a result obtaining community participation poses a challenge.

Almost the entire gamut of activities is carried out by the municipalities themselves. This is in sharp contrast to the situation prevailing in the developing countries where the waste management sector has been privatised to a great extent. In India privatisation has been introduced on a limited scale in a number of municipalities. This is however confined to giving a well defined area to a private contractor to lift and transport the garbage to the point of disposal.

Another notable feature of garbage in the developing countries is that the garbage is extremely heterogeneous. Moreover, the composition of garbage varies with the season and also depends upon the locality from where it originates. The high number of

labourers employed in the low income countries reflect the type of system used. Since containerisation of waste is very limited, these high numbers reflect a large cadre of sweepers and also vehicle crews required to sweep and shovel refuse before it can be loaded.

Legislations regarding solid waste disposal

In developed countries the State Governments have gone a long way and the legislative printing presses have been producing reams of new solid waste recycling and reduction laws. Some local bodies have also developed their own statutes to reduce wastes and in some cases , to mandate service provisions and citizen participation. These laws promote the following waste management practices in the order of priority:

1) source reduction
2) recycling and composting
3) environmentally sound transformation and environmentally safe land disposals
4) ban on disposal of certain hazardous wastes
5) imposition of tax and surcharge for waste disposal

Local municipal bodies in India are competent to frame bye-laws governing waste management. But apart from the metropolitan cities the smaller municipalities have not exercised their powers to formulate any such bye-laws. That is one of the reasons why there is no policy governing the disposal of wastes in most of the towns and cities in the developing world.

Waste management system in a typical 0.5 million city in India (Belgaum)

The garbage generated in the city is not uniform and it depends on the area where it originates.

1) Well developed areas:-the garbage is uniform throughout the year and contains vegetable matter, plastic, paper etc. and it is generally dry.

2) Slum areas :-the garbage contains high moisture, food wastes, animal and human wastes and high proportion of silt and ashes.

3) Market areas:- the type of garbage varies seasonally and it mainly contains vegetables and fruit wastes and is highly moist.

4) Slaughter houses:-the garbage contains animal waste, rejected carcasses, bones, hair etc. This is highly decomposable.

5) Old city areas:-In these parts people still are dependent on agriculture and allied activities. The garbage is agriculture refuse, straws, grass, animal waste etc.

6) Hostel/hotels:- These areas contribute to the municipal garbage in the form of unconsumed food items and other organic stuff.

Types of vehicles used.

S.NO.	TYPE	NO. OF TRIPS	NOS.	CAPACITY IN TONS	TOTAL IN TONS
1	garbage gulper	2	1	5.5	11
2	lorries	2	3	3.0	18
3	small lorries	3	4	2.5	30
4	tractor-trailers	4	5	2.0	40

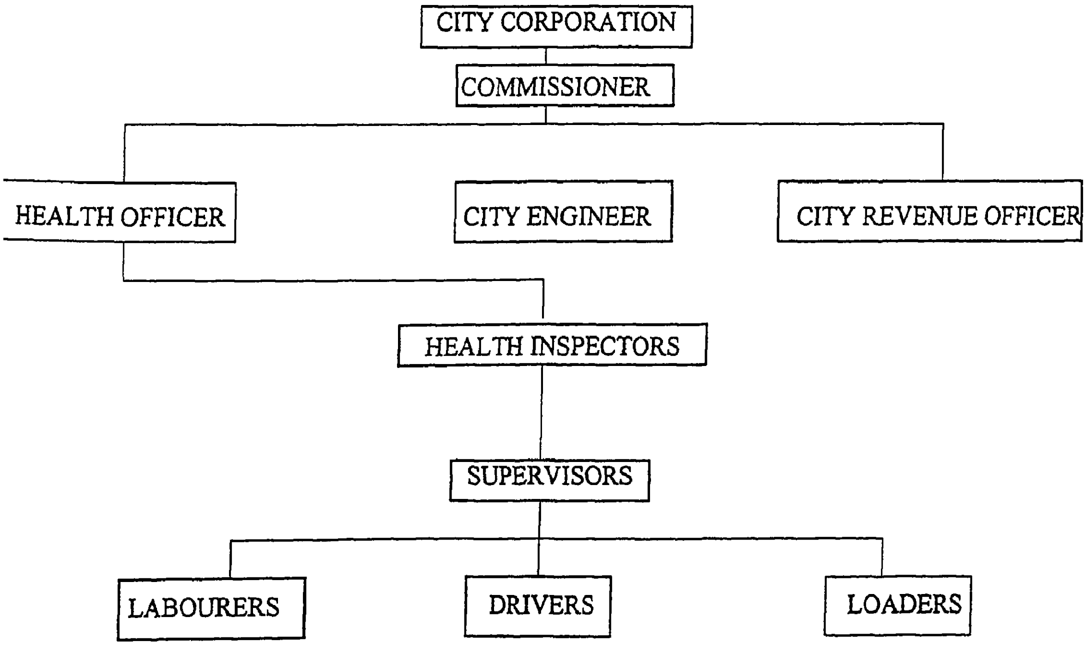
Number of community bins in the city = 800

Each bin is cylindrical in shape with a diameter of .8m and height of 0.8m (volume .4 cu.m)

There are 100 labourers assigned to the vehicles and 800 labourers for cleaning the city.

The City corporation has an annual budget of	Rs 120 million.
salary of staff handling waste	Rs 30 million.
expenditure on maintenance of facilities handling waste	Rs 15 million.

Organisation chart of the city corporation (concerning waste management).



An integrated approach to the problem of solid waste management.

There are several impediments to the use of Western public health (and other) systems in developing countries. These are as follows:

a) climate and seasonal differences

b) budget limitations

c) economy of the region

d) physical characteristics of the cities

e) social and religious customs

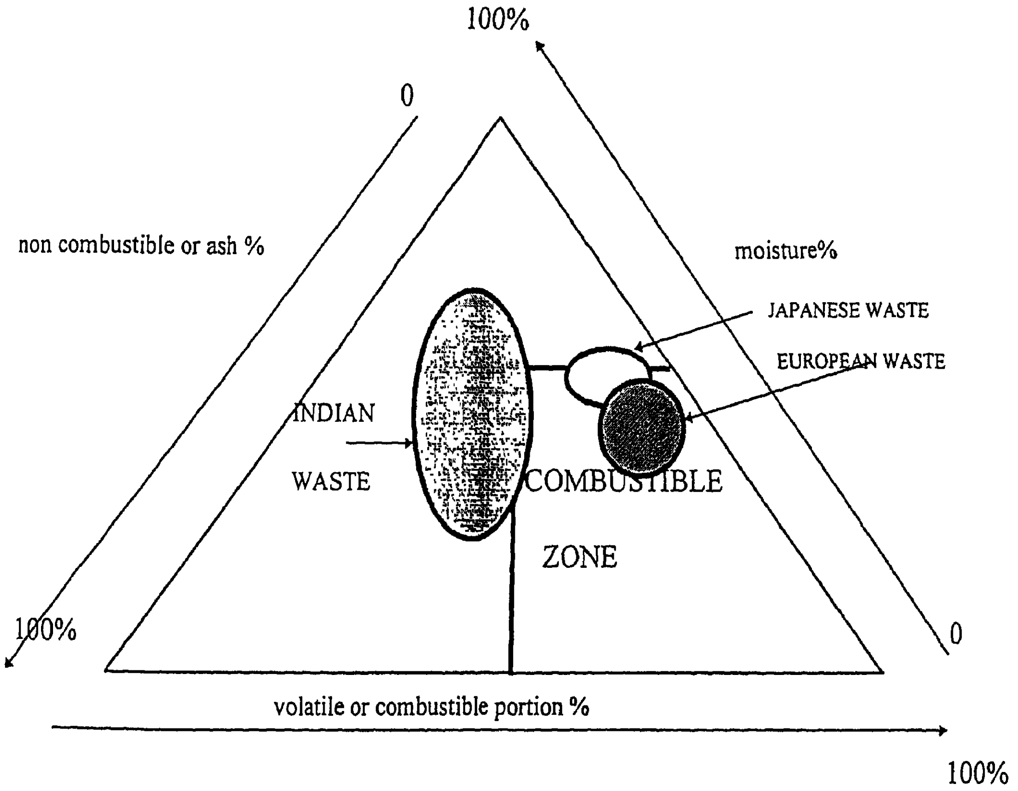
f) public health awareness

g) the quality of management and technical expertise

h) the setting of appropriate environmental standards

As described in the previous chapter the typical characteristics of waste in a city in a developing country are high moisture content, high density and high non-combustible materials. This position is clearly brought out by the following three component diagram.

THREE COMPONENT DIAGRAM SHOWING THE COMBUSTIBILITY OF WASTES



This clearly establishes that burning Indian waste would be very difficult, and any disposal based on burning would be problematic and would involve higher capital investments and would require auxiliary fuels and under no circumstances it would be economically viable. The very high vegetable content of refuse from the poorer areas point to the decomposition particularly as there is pre-separation collection of many contraries like bottles, papers, and rags, which are taken out for reuse/recycling. Erosion

of soil by the tropical rains, the demand for food because of increasing population and the multiple cropping associated with the green revolution suggests that the manure is a much needed commodity.

Therefore the right way to process the solid wastes in a developing country would be to decompose the waste. This decomposition may be via the composting, methane gasification, or the vermiculture route.

It should be kept in mind that all these processes will not result in zero waste. After decomposition also there would be some inert waste. The only way to dispose off that would be in sanitary landfills. The local municipal councils should in consultation with the State Government should identify lands which should be earmarked for reclaimation. Uncontrolled dumping of waste on land or water should be totally prohibited.

It is important to note that the waste generated all over the city is not uniform. Nor is the mode of generation and storage of waste is uniform. Having different processing for these different types of wastes can be thought of .

The philosophy of providing free waste disposal services should brought to an end. There are sections of society which can be asked to pay for these services. Those people living in the well developed areas and in the high income groups, and those in commercial establishments like offices, shops, hotels and restaurants, should be asked to assume more of the cost of solid waste disposal.

The municipalities should realise that in order to increase the abour productivity privatisation may be the answer. Already several local bodies have experimented with

entrusting the work of transportation to private contractors. A Cost benefit analysis may be done between handling different activities of waste management by the local bodies and privatising it.

Adoption of appropriate technologies is necessary. However care should be exercised as modern technologies like compactor vehicles are fantastically expensive and pose many maintenance problems. In the entire process of handling and processing solid wastes in a city the most labour consuming activities are sweeping and loading the garbage into the vehicle. Loading has serious implications as the vehicle is totally idle during the time of loading and the efficiency of the loaders limits the efficiencies of the vehicles. There are few countries in the developing world which do not give high priority to agriculture and the use, wherever possible, of agricultural machinery such as tractors and their associated trailers. Inevitably these have found their way into municipal cleansing services. Relatively simple, usually with a good local infrastructure of repairs and spare parts, the agricultural tractor with a flexible drive 3-4 cu.m tipping trailer is useful equipment. This equipment could be modified by making it low level for easy loading or by attaching a small hydraulic unit which can lift collected garbage from the ground directly.

The motivation level of the workers is extremely low. They have to work under very exacting circumstances. They are exposed to serious health hazards. They should be provided with education training and better health care facilities. They should also be engaged in other productive activities to break their monotony.

The organisational and technical activities encountered in organisation of solid waste disposal requires full public awareness. Creation of a sense of civic responsibility among low income group residents can go a long way in waste management. Their literacy rates may be low but they can definitely be organised into a community which is hygienic and sanitation conscious. The voluntary organisations can be involved to bring about this awareness among the people.

Public participation should be enlisted in order to make the programme of solid waste management a success. Neighbourhood groups can be formed to ensure that the residents do not violate the waste disposal bye-laws. These groups can also keep a watch over the performance of the municipal workers in their locality.

A major challenge in addressing all urban problems is the unsatisfactory health of the municipality's finances. There is a serious need for the municipal bodies to rationalise their tax structure ,and the fees collected for the various services provided by them. The leakages in the revenue collection system need to be plugged and the wasteful expenditures needs to be curbed.

Good labour relations and good productivity are missing. Hundred or thousands of labours are engaged by the municipal bodies. A large number of them squat all day forming little heaps of dust, and other rubbish with a local broom or a bunch of sticks. India spends four times as much on street sweeping as on refuse collection and transportation. The supervisory staff is totally ignorant of modern personnel management. The supervisory staff often is busy with other regulatory work and pays absolutely no attention to the supervision of the garbage collection work. The supervisory staff should

be asked to change their priorities and to concentrate on waste collection and disposal, and to concentrate on proper management of the human resources. It would be worthwhile to try to handover functions of street sweeping and garbage collection, in specific areas of the municipality to private management.

Steps should be taken to have effective zoning regulations to prevent unplanned development and formation of slums. In some cities programmes of slum upgradation have been taken up. Care should be exercised to prevent further growth of slums.

The basis of all activities regarding the disposal of waste should be laid down in the waste disposal laws which should cover the following essential points.

a) Definition of the term solid waste

b) The rights and obligations of the producers and users of the solid wastes and

c) Clarification of the question as to who is responsible for the certain types of wastes must be set forth.

d) Determine how waste should be disposed off.

e) Determine the type and the scope of punishment in the case of violation of the laws.

Providing for the needs of the poor of the world is a tremendous challenge. Much more than good engineering is required; more than good management is needed. There has to be a combination of these with an understanding of the people and their way of life.

Whichever city it is, whichever country is it. The underlying principle of 3 Rs applies universally. REDUCE, REUSE, AND RECYCLE.